APPENDIX

Notes on the identification and ecology of fossil Chironomidae

The conclusions outlined in the main portion of this thesis depend greatly upon the correct identification of fossil Chironomidae. Apart from the mentum, few structures were consistently preserved and retained with the fossil head capsule. Yet, systematic placement of many larval taxa is best achieved with reference to other body parts (e.g. Wiederholm, 1983).

This appendix provides details regarding fossil identification, including uncertainties which exist for several taxonomic decisions. While the immediate intent is to provide a measure of quality assurance, the organization of the appendix has also a practical goal.

With so little research yet devoted to the chironomid fauna of British Columbia, aquatic ecologists or palaeoecologists may find this record useful for identification of chironomids in British Columbia, and perhaps elsewhere. To assist comparisons, illustrations and remarks concerning similar-looking, closely-related taxa have been placed on the same page, or adjacent pages. Terminology follows that proposed by Sæther (1980c). Length of the ventromental plates is measured parallel to the median axis of the head capsule; their breadth is measured perpendicular to this axis.

Since no major changes in chironomid mouthparts, apart from size, occur during the final larval instars, the key, descriptions and illustrations should be reliable for 2nd, 3rd, and 4th instar remains. Illustrations have been prepared from remains of one of these three instars.

This appendix is an excerpt from:
Walker, I. R., 1988. Late-Quaternary Palaeoecology of Chironomidae (Insecta: Diptera) in lake sediments from British Columbia. PhD thesis, Simon Fraser University, Burnaby. 204 pp.

The order of presentation is not alphabetical. The following outline facilitates quick reference to individual taxa. Nomenclature follows Wiederholm (1983), unless otherwise noted.

1a) Head capsule without ligula; antennae non-retractile; mentum conspicuous and, in most taxa, darkly pigmented.... 2.

b) Ligula and retracted 1st antennal segment retained in most fossil head capsules; mentum inconspicuous, weakly pigmented.....Subfamily TANYPODINAE. 4. p.129

2a) Mentum concave; ventromental plates vestigial .....Subfamily CHIRONOMINAE (in part). 7. p.148

b) Mentum convex; or if concave, then ventromental plates conspicuous..... 3.

3a) Ventromental plates very broad, always extending laterally far beyond the outermost mental teeth; most taxa with striated ventromental plates .....Subfamily CHIRONOMINAE (in part). 7. p.148

b) Ventromental plates much smaller, not extending far beyond the outermost mental teeth (except in Nanocladius and Stilocladius); ventromental plates never striated ..Subfamilies DIAMESINAE, ORTHOCLADIINAE and PODONOMINAE. 32. p.175 & 177

SUBFAMILY TANYPODINAE

4a) Median tooth of ligula much longer than adjacent teeth; dorsomental teeth absent.....Tribe Pentaneurini (in part). 5.

b) Median tooth of ligula about as long as adjacent teeth, or shorter, forming a straight or weakly concave distal ligula margin; dorsomental teeth present or absent..... 6.

5a) Lateral margin of head capsule with small, but distinct swelling; several sharp projections scattered over swollen area.....Labrundinia p.129

b) Lateral margin of head capsule without distinct swelling; no sharp projections along lateral margin of head capsule.....Nilotanypus p.129

6a) Dorsomental teeth lacking; head capsule elongate; 1st antennal segment very long and slender....other Pentaneurini p.130

b) Dorsomental teeth present; head capsule broad; 1st antennal segment rather short and broad .....Tribe Macropelopiini: Procladius p.130

SUBFAMILY CHIRONOMINAE

7a) Ventromental plates bar-shaped, nearly touching at median axis of mentum..... 8.

b) Ventromental plates fan-shaped, and (except for Lauterborniella/Zavreliella) widely separated; or

ventromental plates vestigial..... 9.

8a) Second lateral teeth of mentum distinctly smaller than adjacent pair; antennae not on distinct pedestals.....Tribe Pseudochironomini: Pseudochironomus p.149

b) Second lateral teeth equal in size to 3rd lateral teeth, or fewer than 3 pairs of lateral teeth visible; antennal pedestal of most taxa conspicuous .....Tribe Tanytarsini (in part). 10.

9a) Antennal pedestals conspicuous, with distinct apical projection.....Tribe Tanytarsini (in part). 10.

b) Antennae not placed on distinct pedestals .....Tribe Chironomini. 13.

Tribe Tanytarsini

10a) Ventromental plates bar-shaped, nearly touching at median axis of mentum..... 11.

b) Ventromental plates fan-shaped, widely separated..... 12.

11a) Mentum narrow, usually only 3 teeth visible in ventral view; median and lateral mental teeth similarly pigmented.....Corynocera nr. ambigua p.149

b) Mentum broad, with 11 conspicuous teeth; median tooth of some taxa weakly pigmented.....~~Tanytarsus s.lat~~. p.148

sub tribe Tanytarsina

12a) Antennal pedestal with distinctly ridged, or creased apical spur.....Tanytarsini sp.A p.149

b) Spur of antennal pedestal not ridged or creased .....Stempellinella p.149

Tribe Chironomini

13a) Mentum concave..... 14.

b) Mentum weakly to strongly convex..... 15.

14a) Ventromental plates vestigial; all mental teeth dark and strongly sclerotized.....Stenochironomus p.155

b) Ventromental plates broad and conspicuous; with broad, weakly pigmented median tooth.....Cryptochironomus p.155

15a) Outermost teeth (1 or 2 pairs) of mentum distinctly longer than adjacent teeth..... 16.

b) Outermost teeth of similar size to adjacent teeth or smaller..... 17.

16a) Median mental tooth broad, only notched near extreme lateral margins; outermost teeth not much broader than other lateral teeth.....Cryptotendipes p.154

b) Median mental region notched laterally, and often at apex to form 3 or 4 narrow teeth; outermost pair (or pairs) of mental teeth much broader than other

lateral teeth.....Cladopelma p.154

17a) Anterior margin of ventromental plates broadly scalloped; mentum with light pigmentation, and 15 or 16 pointed teeth.....Parachironomus p.154

b) Anterior margin of ventromental plates not scalloped; mentum with light or dark pigmentation, and 13 to 16 teeth..... 18.

18a) Mentum with even number of teeth; or if odd, then median tooth light coloured and shorter than adjacent pair..... 19.

b) Mentum with odd number of teeth; median tooth light or dark-coloured, large and conspicuous..... 28.

19a) Median and 1st lateral pairs of mental teeth more weakly pigmented than other mental teeth; 16 mental teeth.....Paratendipes p.152

b) Either all mental teeth weakly-pigmented, or with fewer than 4 weakly-pigmented teeth; 14 to 16 teeth..... 20.

20a) Median pair, and 2nd lateral pair of mental teeth distinctly longer than 1st lateral teeth..... 21.

b) Median pair of teeth shorter, or subequal to length of adjacent pair..... 24.

21a) Mentum with 16 teeth..... 22.

b) Mentum with fewer teeth..... 23.

22a) All mental teeth small, weakly pigmented; lateral extremity of ventromental plates rounded .....Pagastiella cf. ostansa p.151

b) Mental teeth of normal size, brown to black; lateral extremity of ventromental plates pointed .....Polypedilum p.151

23a) Anterior margin of ventromental plates nearly straight, almost meeting at median axis; all mental teeth weakly pigmented.....Lauterborniella/Zavreliella p.151

b) Anterior margin of ventromental plates distinctly convex, separated by 4 or more teeth; lateral teeth more darkly pigmented than median teeth.....Microtendipes p.151

24a) Median pair of mental teeth much smaller than 1st lateral pair.....Omisus p.152

b) Median and 1st lateral teeth subequal..... 25.

25a) Ventromental plates separated by 6 or more teeth, distinctly and coarsely striated throughout .....Cyphomella/Harnischia/Paracladopelma p.152

b) Ventromental plates separated by 4 or fewer teeth, distinctly or indistinctly striated..... 26.

26a) Mandible with 4 inner teeth; striae near

anterior ventromental margin distinct and widely spaced (adjacent striations are separated by about their apparent length); 3rd lateral teeth of mentum of normal size.....Sergentia p.150

b) Mandible with 2 or 3 inner teeth; striae near anterior ventromental margin closely spaced, but distinct to absent; 3rd lateral teeth of mentum larger than adjacent pairs in most specimens..... 27.

27a) Mandible with short dorsal tooth and 3 inner teeth; ventromental striae long, easily discernible in anterior and posterior fields; median teeth of mentum distinctly separated.....Tribelos p.150

b) Mandible with long dorsal tooth, and 2 or 3 inner teeth; ventromental striae indistinct or not discernible, anterior striae very short; median pair of mental teeth fused in some specimens .....Stictochironomus p.150

28a) All mental teeth dark, similarly pigmented; median origin of ventromental plates not associated with median tooth..... 30.

b) Median tooth pale, lateral teeth dark or light; ventromental plates projecting forward in median area, having origin associated with median tooth..... 29.

29a) Median tooth very broad, composing ca. 1/3 of

mental width; mandible not sickle-shaped; 3 inner mandibular teeth.....Paralauterborniella p.155

b) Median tooth not exceptionally broad, composing ca. 1/5 of mental width; mandible sickle-shaped; 4 inner mandibular teeth.....Nilothauma p.155

30a) Median tooth distinctly trifid (except when strongly worn), and flanked by 6 lateral pairs; anterior ventromental margin smooth; striae discernible in posterior field only.....Chironomus p.153

b) Median tooth often notched laterally, but not distinctly trifid; median tooth flanked by 6 lateral pairs; ventromental plates distinctly striated, with most specimens having finely crenate anterior margin..... 31.

31a) Width of each ventromental plate about as wide, or wider than mentum; mental teeth low, rounded.Glyptotendipes p.153

b) Width of each ventromental plate about 3/4 of mental width; mental teeth long, separated by deep notches.....Dicrotendipes p.153

SUBFAMILIES DIAMESINAE, ORTHOCLADIINAE and PODONOMINAE

32a) Head capsule with numerous long setae (position of setae may be apparent only by their insertions

when the setae have been lost from fossils);
mentum weakly convex with 2 distinct pairs of
lateral teeth.....Protanypus p.175

b) Head capsule with normal number of setae; if
mentum weakly convex, then mentum has 4 or more
pairs of distinct lateral teeth..... 33.

33a) Submental setae set far back on head capsule,
(distance of setae from posterior head capsule
margin less than, or equal to, distance from
setae to mentum)..... 34.

b) Submental setae closer to mentum than posterior
margin of head capsule..... 35.

34a) Ventromental plates wholly or partially
concealing lateral teeth of the mentum; mentum
with one broad median tooth.....Pagastia p.176

b) Ventromental plates not overlapping or concealing
any mental teeth; mentum with even number of teeth,
or if mentum has odd number of teeth, then median
tooth small and narrow.....Brillia/Euryhapsis p.177

35a) Mentum with 4 or more pairs of lateral teeth..... 36.

b) Mentum with 2 pairs of lateral teeth
.....Orthocladius (Symposiocladius) lignicola p.178

36a) Mentum with pronounced bands of greater and

lesser sclerotization in lateral regions of mentum; ventromental plates not overlapping mental teeth; head capsule yellowish to brown....*Eukiefferiella*/*Tvetenia* p.184

b) Mentum without pronounced sclerotization banding in lateral regions of mentum; ventromental plates may or may not overlap teeth of mentum; head capsule pigmentation transparent to yellowish or brown..... 37.

37a) Median mental tooth with 2 pronounced median points, weakly pigmented; first 2 pairs of lateral teeth lighter in colour than subsequent pairs; lateral teeth with truncated appearance .....*Nanocladius* cf. *distinctus* p.183

b) Median mental tooth without pronounced median points, weakly to strongly pigmented; if first 2 pairs of lateral teeth are lighter in colour than subsequent pairs, then lateral teeth without truncated appearance..... 38.

38a) Mentum with odd number of teeth; median tooth without median notch and distinctly broader (2x or more) than any lateral tooth..... 39.

b) Mentum with even number of teeth; or if mentum has odd number of teeth, then median tooth either medially notched, or not distinctly broader than any lateral tooth..... 47.

39a) Ventromental plates completely overlapping all pairs of lateral teeth.....Potthastia? p.176

b) Ventromental plates smaller, some lateral mental teeth extend beyond anterior ventromental margin of flattened head capsule..... 40.

40a) Ventromental plates wholly or partially overlapping some mental teeth, with approximately straight or weakly concave antero-lateral margins; median tooth dark; premandible simple.Psectrocladius subg. Monopsectrocladius p.181

b) Ventromental plates not overlapping mental teeth; or if wholly or partially overlapping mental teeth, then either antero-lateral margin convex, or median tooth with little or no pigmentation; premandible simple or compound..... 41.

41a) Ventromental plates very broad in submental region.....Stilocladius p.179

b) Ventromental plates not exceptionally broad in submental region..... 42.

42a) Median tooth flanked by 2 pairs of light coloured lateral teeth .....Cricotopus/Orthocladius/Paratrichocladius (in part) p.178

b) Median tooth flanked by 1 pair of light

coloured lateral teeth; or all lateral teeth similarly pigmented..... 43.

43a) Median tooth notched laterally .....Parakiefferiella cf. bathophila p.180

b) Median tooth unnotched..... 44.

44a) 2nd lateral teeth distinctly smaller than adjacent teeth (but 1st and 2nd lateral teeth absent when mouthparts strongly worn); median tooth as dark as lateral teeth.....Parakiefferiella sp.A p.180

b) 2nd lateral teeth of similar size to adjacent pairs; median tooth with light or dark pigmentation..... 45.

45a) Median tooth very broad, and with little, if any pigmentation..... 46.

b) Median tooth less broad, with distinct pigmentation (varying from pale yellow or tan to dark brown).....Smittia/Pseudosmittia? group p.178

46a) Median tooth strongly arched .....Parakiefferiella? cf. triquetra p.180

b) Median tooth weakly arched..... Paracladius p.179

47a) Mentum with even number of teeth; each median tooth is distinctly broader (1.5 or more x) than

the adjacent 2nd lateral tooth..... 48.

b) Mentum with odd number of teeth; or if mentum has even number of teeth, then median tooth of similar width to 2nd lateral tooth..... 56.

48a) Mentum with 4 pairs of lateral teeth.....Synorthocladius p.185

b) Mentum with 5 or more pairs of lateral teeth..... 49.

49a) Ventromental plates partially overlapping one or more lateral teeth of mentum; most species with a straight or weakly convex antero-lateral ventromental margin; median pair of teeth without accessory teeth; premandible simple...other Psectrocladius p.181

b) Ventromental plates smaller; or if ventromental plates overlap some mental teeth, then antero-lateral margin distinctly convex; median pair of mental teeth with or without accessory teeth; premandible simple or compound..... 50.

50a) Ventromental plates with complex layered structure, probably double; 4th lateral teeth of mentum as long, or longer than 3rd lateral teeth .....Parametriocnemus group p.183

b) Ventromental plates single, without complex layered structure; 4th lateral teeth of mentum shorter than 3rd lateral teeth..... 51.

51a) Median pair of teeth weakly separated..... 52.

b) Median pair of mental teeth distinctly separated..... 53.

52a) 1st lateral mental teeth closely appressed to median pair; ventromental plates extend at least to base of outermost lateral tooth.....Hydrobaenus p.182

b) 1st lateral teeth distinctly separated from median pair; ventromental plates not extending to base of outermost lateral tooth .....Doithrix/Pseudorthocladius? group p.184

53a) Ventromental plates poorly developed (antero-lateral margin of ventromental plates not extending to base of outermost lateral teeth); median teeth lacking accessory teeth.....Limnophyes p.184

b) Ventromental plates extend at least to base of outermost lateral teeth; median teeth with or without accessory teeth..... 54.

54a) Median pair of mental teeth as dark as laterals, and uniformly pigmented; ventromental beard absent; premandible indistinctly bifid .....Heterotrissocladius p.182

b) Median pair of mental teeth in most specimens more weakly pigmented than laterals, and weakly banded; ventromental beard preserved on some specimens; premandible either simple or distinctly

bifid..... 55.

55a) Submental setae set close to ventromental plates (distance from setae to ventromental plates less than breadth of plates), and posterior to 3rd or 4th lateral teeth; premandible simple.....Rheocricotopus p.183

b) Submental setae farther from ventromental plates (distance from setae to ventromental plates greater than breadth of ventromental plates), and posterior to 2nd or 3rd lateral teeth; premandible distinctly bifid.....Zalutschia p.182

56a) Median mental region with concave area formed by median pair of teeth and 1st and 2nd lateral teeth .....Heterotanytarsus cf. perennis p.185

b) Median region of mentum convex..... 57.

57a) Ventromental plates wholly or partially overlapping most lateral teeth; median tooth and 1st lateral teeth subequal; 6th lateral teeth distinctly longer than adjacent pairs.....Pseudodiamesa p.176

b) Ventromental plates not extending to base of lateral mental teeth; median mental region variable; 6th lateral teeth similar to adjacent mental teeth..... 58.

58a) Lateral region of mentum very steeply sloping

(ca. 60°); median 2 or 3 teeth projecting distinctly beyond adjacent mental teeth; mentum with 12 or 13 teeth.....Corynoneura/Thienemanniella p.177

b) Lateral region of mentum less steeply inclined (ca. 45°); median teeth not projecting distinctly beyond adjacent teeth; mentum with 13 or more teeth.... 59.

59a) Mandible with 8 teeth; mentum with 1 median tooth and 7 or 8 pairs of lateral teeth.....Boreochlus p.175

b) Mandible with fewer than 8 teeth; mentum with 1 or 2 median teeth, and 6 to 11 pairs of lateral teeth..... 60.

60a) Mentum with odd number of teeth; median tooth flanked by 6 or 7 pairs of lateral teeth .....Cricotopus/Orthocladius/Paratrichocladius (in part) p.178

b) Mentum with odd or even number of teeth; median tooth (or teeth) flanked by 7 to 11 pairs of lateral teeth.....Diamesa? p.175

Notes regarding individual taxa

Subfamily Tanypodinae

Tribe Pentaneurini

Labrundinia Fittkau (Fig. A.1a–c)

The elongate head capsules of *Labrundinia* have two slightly swollen regions, one along either lateral margin, which bear several sharp projections (Fittkau and Roback, 1983). This feature may be unique to *Labrundinia*. The median tooth of the 5–toothed ligula is distinctly longer than the remaining teeth. A similar ligula arrangement is reported for *Nilotanypus* (Fittkau and Roback, 1983). The mandible bears two inner teeth.

Labrundinia has been reported from subarctic to tropical regions (Fittkau and Roback, 1983; Wiens *et al.*, 1975), preferring bogs and still or slow–moving water (Fittkau and Reiss, 1978; Oliver and Roussel, 1983a). *Labrundinia pilosella* (Loew) has been collected at Kaslo, British Columbia (Roback, 1971). In this study, remains of *Labrundinia*, were found in Deer and Stump Lakes only.

Nilotanypus Kieffer (Fig. A.1d–f)

The 5–toothed ligula of *Nilotanypus* is similar to that of *Labrundinia*, having a median tooth which projects distinctly beyond adjacent teeth. This ligula arrangement is not described for other Tanypodinae genera (Fittkau and Roback, 1983). The more rounded lateral margins of the head capsule, and absence of lateral pointed projections, distinguish *Nilotanypus* from *Labrundinia*. The mandible bears two inner teeth.

In North America, *Nilotanypus* is reported from Florida and Arizona, north to the subarctic Northwest Territories, but no previous record is available for British Columbia (Oliver, 1981a; Oliver and Roussel, 1983a; Roback, 1971). The larvae inhabit flowing

water (Oliver and Roussel, 1983a). In this study, remains of *Nilotanypus*, were only found in the Holocene sediments of Marion Lake.

other Pentaneurini (Fig. A.2a–c)

The narrow head capsule (cephalic index 0.40 – 0.67: Fittkau and Roback, 1983), long slender basal antennal segment, and absence of dorsomental teeth are important characteristics distinguishing the tribe Pentaneurini from other Tanypodinae. No attempt has been made at further subdivision of this difficult group (apart from distinguishing *Labrundinia* and *Nilotanypus* as described above). Although first instar head capsules with 4 ligular teeth were noted, all other fossil ligulas included 5 teeth. These teeth formed a straight or weakly–concave distal ligula margin. Canadian genera sharing these characteristics include *Ablabesmyia* Johannsen, *Arctopelopia* Fittkau, *Conchapelopia* Fittkau, *Guttipelopia* Fittkau, *Larsia* Fittkau, *Monopelopia* Fittkau, *Natarsia* Fittkau, *Paramerina* Fittkau, *Pentaneura* Philippi, *Thienemannimyia* Fittkau, *Trissopelopia* Kieffer, and *Zavrelimyia* Fittkau (Fittkau and Roback, 1983; Oliver, 1981a; Oliver and Roussel, 1983a).

The Pentaneurini are widely distributed throughout the world, but Oliver and Roussel (1983a) only regard *Arctopelopia* as an arctic genus. Low arctic records also exist for *Ablabesmyia*, *Conchapelopia*, and *Pentaneura* (Danks, 1981). The Pentaneurini are common in both lotic and lentic waters (Fittkau and Reiss, 1978). Hamilton (1965) reports *Ablabesmyia monilis* (Linnaeus), *Larsia acrocincta* (Goetghebuer), *Thienemannimyia*, *Zavrelimyia*, and several undetermined Pentaneurini at Marion Lake.

Tribe Macropelopiini

Procladius Skuse (Fig. A.2d–g)

The broad head capsule of *Procladius* fossils, and presence of dorsomental teeth distinguish this genus from the Pentaneurini. Apart from first instar head capsules, the

ligula always has 5 dark teeth. This feature is rare in the tribe Coelotanypodini (Oliver and Roussel, 1983a). The dorsomental plate and dorsomental teeth are distinct and strongly sclerotized. The first antennal segment is relatively short and broad. Members of the tribe Tanypodini have a ligula with convex to straight distal ligula margins, whereas those of the Macropelopiini are concave. The mandibles of Tanypodini have broad bases (Oliver and Roussel, 1983a). No other Canadian Macropelopiini have a ligula with 5 dark teeth (Oliver and Roussel, 1983a).

The genus *Procladius* is widespread, even occurring in shallow high arctic lakes and ponds (Danks and Oliver, 1972a, b). Hamilton (1965) reports four species at Marion Lake, *P. denticulatus* Sublette, *P. freemani* Sublette, *P.* sp.A, and *P.* (*Psilotanypus*) *bellus* (Loew). Roback (1971) indicates that *P. nietus* Roback, *P. culiciformis* (Linnaeus), and *P. ruris* var. *grandis* Roback also occur in British Columbia.

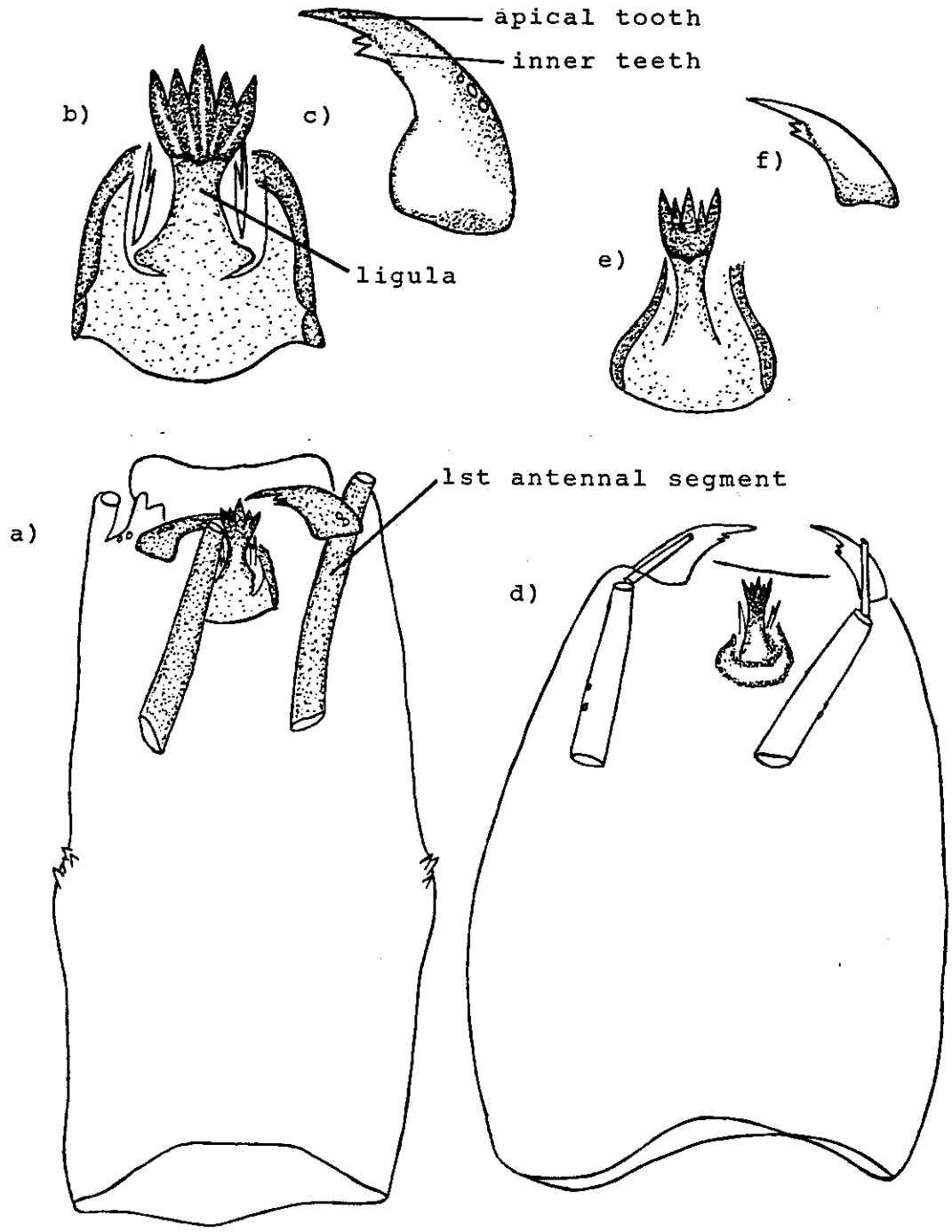

Figure A.1 Tanypodinae: Pentaneurini: *Labrundinia* Fittkau: a) head capsule (340X), b) premento-hypopharyngeal complex (730X), c) mandible (730X) - *Nilotanypus* Kieffer: d) head capsule (610X), e) premento-hypopharyngeal complex (1600X), f) mandible (1600X)

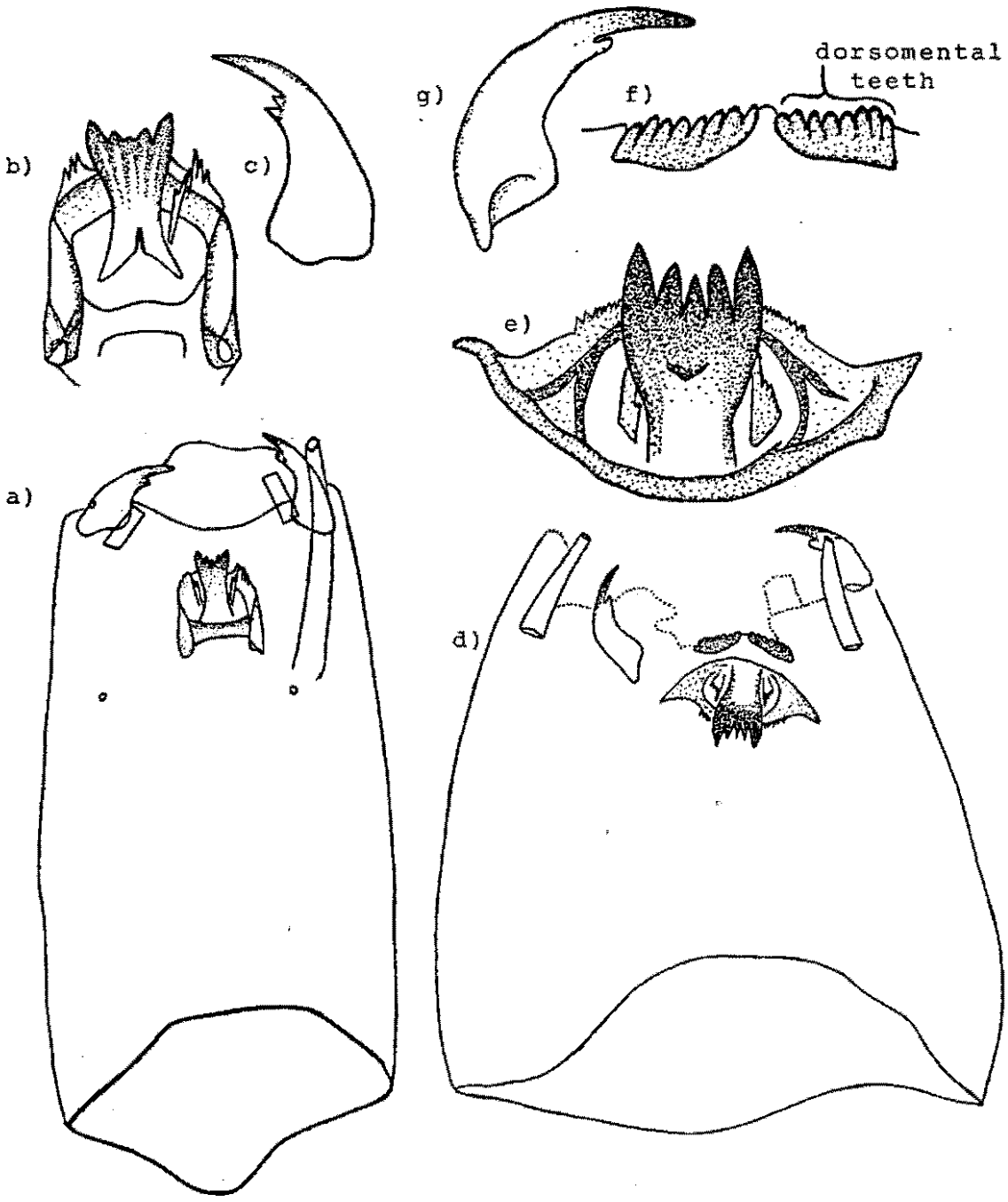

Figure A.2 Tanypodinae: Pentaneurini and Macropelopiini: other Pentaneurini: a) head capsule (310X), b) premento-hypopharyngeal complex (780X), c) mandible (780X) - *Procladius* Skuse: d) head capsule (100X), e) premento-hypopharyngeal complex (280X), f) dorsomentum (280X), g) mandible (280X)

Subfamily Chironominae

Tribe Tanytarsini

Tanytarsus v.d.Wulp s.lat. (Fig. A.3a-g)

Fossils attributed to *Tanytarsus* s.lat. typically included 1 median mental tooth and 5 lateral teeth, although a considerable diversity of form was noted. The median tooth of many fossils was weakly-pigmented. The median tooth of some fossil specimens was notched laterally. The lateral teeth were all similar in size and pigmentation. The striated ventromental plates were bar-shaped, several times broader (laterally) than long. These plates nearly meet at the median axis. Prominent antennal pedestals were noted on most fossil head capsules. The pedestals often included small apical projections, similar to those of many *Micropsectra* Kieffer species. The mandibles normally included 1 dorsal tooth, one dark apical tooth, and 3 inner teeth. In the rare instances when a premandible was retained with the fossil, 3 or 4 distinct apical teeth were usually noted. Thus, most fossils probably belong to *Tanytarsus* s.str. or *Cladotanytarsus*. However, several other genera (e.g. *Micropsectra*, *Paratanytarsus* Thienemann & Bause, and *Rheotanytarsus* Thienemann & Bause) will be included. The presence of fossils (Fig. A.3c&f) with a distinct group of 3 central teeth (the median tooth and 1st lateral pair), flanked by 4 additional pairs of lateral teeth is worthy of note. The mentum and mandible of these specimens resemble that of *Corynocera oliveri* Lindeberg, especially the worn mouthparts illustrated by Hofmann (1985).

The genera possibly included in *Tanytarsus* s.lat. are distributed in lotic and lentic habitats throughout the world, including high arctic regions (Danks, 1981; Pinder and Reiss, 1983). Hamilton (1965) notes the presence of 2 species of *Micropsectra* (as *Lundstroemia* Kieffer) and 4 species of *Tanytarsus* at Marion Lake. *C. oliveri* has not yet been discovered in North America (Pinder and Reiss, 1983), although Hofmann (1983b)

reports this species as a subfossil in northwestern Greenland. *C. oliveri* group fossils were noted at "Aqua Incognito", Black Tusk, "Hippa", Mimulus and Russet Lakes. *Corynocera oliveri* group head capsules are possibly the most common chironomid remains in high elevation coastal lakes.

Corynocera nr. *ambigua* Zett. (Fig. A.4a–c)

Corynocera nr. *ambigua* fossils are conspicuous, by virtue of the narrow mentum, typically with 3 teeth visible in ventral view. Other lateral teeth may be present, but would be hidden behind the median tooth and 1st lateral teeth. The broad, bar–shaped ventromental plates nearly meet at the median axis. The teeth of the mandibles were usually indistinct, but this partially results from abrasion of mouthparts. The antennal pedestals are pronounced, including a small, blunt apical projection.

I have examined collections of *Corynocera ambigua* group fossils from the forest–tundra region near Yellowknife, Northwest Territories. Since these differ from the British Columbia material, at least two species may be represented in North America. The British Columbia collections differ by having a darker, more variable mentum. The apical projection of the antennal pedestals could not be distinguished on head capsules from the Yellowknife area. Livingstone (1953) noted that collections from Alaska more closely resembled *C. duffi* (Deevey) than *C. ambigua*. Downes (1962) claims the existence of an undescribed species in southern Alberta.

Corynocera ambigua is widely–distributed in shallow lentic habitats at northern latitudes, and is known from northern Asia, Europe, and northwestern North America, including the low arctic (Danks, 1981; Fittkau and Reiss, 1978). The only record of the *C. ambigua* group from eastern North America, is as a fossil in near surface lake sediments from Cape Breton Island, Nova Scotia (D.A. Livingstone, pers. comm.). Although the genus is previously unknown in British Columbia, it has been recorded in

Alaska, the Northwest Territories, Alberta, and Wyoming (Coffman and Ferrington, 1984; Downes, 1962; Livingstone *et al.*, 1958; Moore, 1978). The genus has also been reported from New Zealand (Pinder and Reiss, 1983).

Stempellinella Brundin (Fig. A.4d–f)

The median tooth and 1st lateral teeth of *Stempellinella* are fused, and flanked by 5 additional pairs of lateral teeth, forming a weakly convex mentum. The broad, fan–shaped ventromental plates are widely separated, and distinctly striated. Mandibles include 1 lightly–pigmented dorsal tooth, a dark apical tooth, and 3 inner teeth. When retained, the premandibles included 3 distinct apical teeth. A long, smooth, and undivided apical projection is a conspicuous feature of the antennal pedestals. The closely–related genus *Zavrelia* is very similar, although the premandible differs slightly in shape, and includes 4 apical teeth (Pinder and Reiss, 1983).

Stempellinella is probably widely–distributed in North American lotic and lentic waters (Bass, 1986; Oliver and Roussel, 1983a; Pinder and Reiss, 1983), but is rare in the arctic. *Stempellinella minor* (Edwards) is reported from Toolik Lake in arctic Alaska (Hershey, 1985a). Hamilton (1965) has described larvae similar to my fossils at Marion Lake. Although he refers to these as *Zavrelia* sp.A, he notes that they belong with *Stempellinella* according to Brundin's (1948) classification. Sæther (1970) also records collections from Okanagan Lake, as *Zavrelia* "Stempellinella" group.

Tanytarsini sp.A (Fig. A.4g–i)

The 1st lateral teeth of Tanytarsini sp.A are closely appressed or fused to the median tooth and accompanied by 5 additional lateral pairs. The mentum is usually weakly convex, although a distinctly concave mentum was apparent with several specimens. Distinct striae are apparent across the widely–separated, fan–shaped ventromental plates.

The teeth of the mandible are dark, including 1 small dorsal tooth, an apical tooth, and two inner teeth. A prominent, distinctly ridged apical projection extends from the antennal pedestals.

The generic placement of these fossils is uncertain. They could belong with *Constempellina* Brundin, *Stempellinella*, *Thienemanniola* Kieffer, or *Zavrelia* Kieffer. The specimens including a concave mentum are suggestive of *Thienemanniola*. Hofmann's (1971b) illustrations of *Thienemanniola* also indicate a similarly ridged apical projection extending from the antennal pedestal. *Thienemanniola*, however, is known only from north-central Europe (Fittkau and Reiss, 1978; Pinder and Reiss, 1986). I have collections of Tanytarsini sp.A remains from Deer Lake, and Holocene sediments of Mike and Misty Lakes.

Tribe Pseudochironomini

Pseudochironomus Malloch (Fig. A.4j-k)

The dark mentum of *Pseudochironomus* includes one median tooth and 6 pairs of lateral teeth. The 2nd lateral teeth are distinctly smaller than adjacent pairs. The broad ventromental plates are bar-shaped, nearly meeting at the median axis, but are not so broad as those of *Tanytarsus* s.lat. remains. The antennal pedestal is short and inconspicuous. Mandibles include an apical tooth, and 3 inner teeth. I have found the reduced 2nd lateral teeth useful for distinguishing fossil head capsules of *Pseudochironomus* from *Tanytarsus* s.lat. remains, although this feature is not shared by all *Pseudochironomus* (Sæther, 1977). The absence of a prominent antennal pedestal is an additional aid to identification.

In this study, remains of *Pseudochironomus*, were found in the surface sediments of Hicks and Lost Lakes, and the Holocene sediments of Marion Lake. The larvae are

widely distributed in lotic and lentic habitats throughout North America (Sublette and Sublette, 1965; Pinder and Reiss, 1983), but have not been recorded from arctic sites (Danks, 1981). *Pseudochironomus* larvae have previously been reported from Okanagan Valley lakes (Sæther, 1970; Sæther and McLean, 1972).

Tribe Chironomini

Sergentia Kieffer (Fig. A.5a–b)

In *Sergentia* fossils, the median teeth and 1st lateral teeth are largest and project beyond the remaining 6 pairs of lateral teeth. The median and 1st lateral teeth also separate a pair of broad, fan–shaped ventromental plates. Striations are easily discernible only near the anterior margin of the ventromentum. These striations are coarse and sparsely distributed. Adjacent striation pairs are separated by approximately their apparent length. The mandibles have 1 dorsal tooth, 1 apical tooth, and 4 inner teeth. Pinder and Reiss (1983) note that the presence of four inner mandibular teeth distinguishes *Sergentia* from several similar genera (e.g. *Phaenopsectra* Kieffer, *Tribelos*). Since mandibles were infrequently retained with fossils, the ventromental striation pattern was considered diagnostic. This appears to be reliable for my material, but may not be useful elsewhere.

Sergentia species are reported from profundal and sublittoral zones in lakes, and are considered to be cold–stenothermal (Pinder and Reiss, 1983). The genus is reported principally from northern regions, including the arctic, in both Europe and North America (Danks, 1981; Fittkau and Reiss, 1978; Sublette and Sublette, 1965). Bass (1986) notes its presence in Texas. Hamilton (1965) has reared larvae of *Sergentia* sp.A from Marion Lake.

Stictochironomus Kieffer (Fig. A.5c–d)

The mentum of *Stictochironomus* fossils is similar to that of *Sergentia* in general form, with the median pair of teeth, and 1st lateral teeth projecting distinctly beyond the remaining 6 lateral pairs. The teeth are usually more rounded than for *Sergentia*, although this character may partially result from abrasion in mineral sediments. The median pair of teeth may be indistinctly separated, or completely fused. Ventromental striations, when visible, were short, closely-spaced, and only discernible near the anterior margin of the ventromental plates. Associated mandibles had 1 long dorsal tooth, 1 apical tooth, and 2 or 3 inner teeth. Although the mentum of several genera (ie. *Phaenopsectra*, *Sergentia*, *Tribelos*) may resemble *Stictochironomus*, these genera usually have a shorter dorsal mandibular tooth, and either 3 or 4 inner teeth (Pinder and Reiss, 1983). Since mandibles were infrequently retained with the head capsules, the striation pattern of ventromental plates was normally used for separation from similar-looking genera. This character may not be useful elsewhere. My material may represent a single species.

Stictochironomus species occur in lakes and streams throughout North America and Europe, including the high arctic (Danks, 1981; Fittkau and Reiss, 1978; Pinder and Reiss, 1983; Sublette and Sublette, 1965). In my British Columbia surface collections, it was almost always associated with *Heterotrissocladius*, *Paracladius*, *Parakiefferiella* sp.A, and *Protanypus* in cold, high-elevation waters. Sæther (1970) reports *Stictochironomus* cf. *rosenscholdi* (Zetterstedt) with *Heterotrissocladius oliveri* Sæther (as *H.* near *subpilosus* (Kieffer) in the profundal zone of Skaha Lake, Okanagan Valley, B.C.

Tribelos Townes (Fig. A.5e–f)

In *Tribelos* fossils, like *Sergentia* and *Stictochironomus*, the median pair of teeth, and 1st lateral teeth project slightly beyond other teeth of the mentum. Of the remaining

pairs of lateral teeth, the 3rd laterals are largest, distinctly longer than the 2nd lateral pair in most specimens. The ventromental plates bear distinct, closely-spaced striae. Two distinct bands of striations are apparent, one across the median region, and another at the anterior ventromental margin. The mandible includes one dorsal tooth, 1 apical tooth, and 3 inner teeth. *Tribelos* was most reliably separated from *Sergentia* and *Stictochironomus* on the basis of the ventromental striation pattern.

Tribelos is widely distributed in the littoral of lakes from subarctic to subtropical latitudes (Pinder and Reiss, 1983). Although I cannot distinguish *Tribelos* from *Phaenopsectra* s.str., Hamilton (1965) reports *Tribelos protextus* (Townes) at Marion Lake.

Lauterborniella Thienemann & Bause/*Zavreliella* Kieffer (Fig. A.6a)

The lightly-pigmented mentum of *Lauterborniella/Zavreliella* bears 7 pairs of teeth. The median pair, and 2nd lateral teeth are long, projecting distinctly beyond the minute 1st laterals. The broad, fan-shaped ventromental plates are striated. The plates differ from those of most Chironomini by having a nearly straight anterior margin, and by nearly meeting along the median axis. Although the above characters readily distinguish *Lauterborniella* and *Zavreliella* from other genera, I have not distinguished between these two genera. My material is closest to *Lauterborniella* as illustrated, and described by Pinder and Reiss (1983).

In this study, remains of *Lauterborniella/Zavreliella*, were found in Stump Lake, Hicks Lake and Holocene sediments from Mike and Misty Lakes. *Lauterborniella* and *Zavreliella* appear to be widely distributed in North America, south of tree-line (Pinder and Reiss, 1983; Sublette and Sublette, 1965). These genera are normally associated with shallow water vegetation, in both lotic and lentic habitats (Pinder and Reiss, 1983). Although *Lauterborniella* has been reported from Char Lake, N.W.T. (Andrews and Rigler, 1985; Davies, 1975; Rigler, 1978; Welch, 1973), these reports clearly result from

confusion of this genus with *Lauterbornia* Kieffer. *Lauterbornia sedna* Oliver (1976) was originally described from Char Lake collections.

Microtendipes Kieffer (Fig. A.6b)

The median mental region of *Microtendipes* is weakly-pigmented, with two long teeth, separated in some specimens by a smaller 3rd tooth at the median axis. The six remaining pairs of lateral teeth are dark. The 2nd lateral teeth are as long, or longer than the median pair, but the 1st lateral teeth are short, and closely-appressed to the 2nd pair. The ventromental plates are distinctly and coarsely striated, and are separated by the median teeth and 1st and 2nd lateral pairs. The arrangement of teeth is similar to *Lauterborniella*, *Polypedilum*, and *Zavreliella*, but the median teeth are more lightly pigmented than the lateral teeth in *Microtendipes*.

Microtendipes larvae are widely-distributed in shallow lotic and lentic habitats south of tree-line. In the Canadian arctic *Microtendipes* has been collected only from the southernmost tundra (Moore, 1978). Hamilton (1965) records *Microtendipes pedellus* (de Geer) from Marion Lake.

Pagastiella cf. *ostansa* Webb (Fig. A.6c)

The mentum of *Pagastiella* cf. *ostansa* includes 8 pairs of small, weakly-pigmented teeth. The median pair and the 2nd lateral teeth are of a similar size and length, but the 1st laterals are minute. Ventromental plates are distinctly striated, and strongly arched, with rounded posterior-lateral margins. The small, light-coloured teeth, and strongly-arched ventromental plates readily distinguish this genus. Only *Pagastiella ostansa* is known from the Nearctic.

Pagastiella Brundin has been collected at Marion Lake (Hamilton, 1965), and is widely-distributed in Canada, south of treeline (Oliver and Roussel, 1983a). The genus is

also recorded from Michigan, and Washington states (Oliver, 1981a; Wiederholm, 1976). Bass (1986) reports "*Pagastiella* ? *ostansa*" from eastern Texas. The larvae inhabit shallow lentic waters (Oliver and Roussel, 1983a; Pinder and Reiss, 1983)

Polypedilum Kieffer (Fig. A.6d)

As in *Lauterborniella*, *Microtendipes*, *Pagastiella*, and *Zavreliella*, the median and 2nd lateral teeth are long in *Polypedilum* fossils. The 1st lateral teeth are distinctly shorter. In total the mentum includes 8 pairs of moderately to strongly-pigmented teeth. The broad, fan-shaped ventromental plates are widely separated. Although the mentum of most early instar head capsules is weakly-pigmented in some specimens, resembling *Lauterborniella*, the shape of the ventromental plates facilitates identification. *Polypedilum* normally has a greater number of mental teeth than either *Lauterborniella* or *Microtendipes*. Although the genus *Polypedilum* is very heterogeneous (Pinder and Reiss, 1983), all of the fossil material conforms to the "normal" type described above. In several known species, the mental teeth are all of approximately equal size (Pinder and Reiss, 1983).

Polypedilum species are very widely-distributed in both lotic and lentic waters, except in arctic and alpine regions (Pinder and Reiss, 1983). The genus has been collected in the southernmost Canadian arctic (Moore, 1978). Hershey (1985a) reports one *Polypedilum* larva at Toolik Lake in arctic Alaska. Three species, *P. nubeculosum* (Meigen), *P. tritum* (Walker), and *P. simulans* Townes are reported from Marion Lake (Hamilton, 1965).

Cyphomella Sæther/*Harnischia* Harnisch/*Paracladopelma* Harnisch (Fig. A.7a-b)

Cyphomella, *Harnischia*, and *Paracladopelma* have similar arrangements of mental teeth and ventromental plates. Although my fossils seem closest to *Paracladopelma* as

described by Pinder and Reiss (1983), the correct generic placement is uncertain. The mentum is weakly-arched, including 8 pairs of similarly-pigmented teeth. The median and 1st lateral pairs of mental teeth project slightly beyond the remaining pairs. The fan-shaped ventromental plates are very widely separated, about as wide as the mentum, and taper to an acute lateral margin. These plates are coarsely striated and weakly crenate along the anterior ventromental margin. The premandible includes four teeth. The 2 apical teeth are longer than the 2 inner premandibular teeth. Hamilton (1965) has described a similar larva, which he tentatively associated with *Parachironomus potamogeti* (Townes) (as *Harnischia potamogeti* Townes). This association is probably incorrect. Hamilton (1965) also collected *Paracladopelma galaptera* (Townes) (as *Harnischia galaptera* Townes) adults from Marion Lake.

Harnischia and *Paracladopelma* appear to be widely-distributed in lotic and lentic habitats south of treeline (Oliver and Roussel, 1983a). *Paracladopelma* is considered somewhat cold-stenothermic (Pinder and Reiss, 1983). *Cyphomella* occurs in large rivers of central North America (Oliver and Roussel, 1983a; Sæther, 1977). In this study, remains of *Cyphomella/Harnischia/Paracladopelma*, were found in the late-glacial sediments of Marion Lake, Holocene sediments of Mike Lake, and surface sediment from Deer and Mystery Lakes.

Omisus Townes (Fig. A.7c)

The mentum of *Omisus* fossils includes 8 pairs of dark teeth and a concave median region. The median pair of teeth are short. The 1st lateral teeth are long, projecting distinctly beyond the median pair. Ventromental plates are broad, striated and fan-shaped, separated by the 8 teeth closest to the median axis. The concave median region, formed by 3 pairs of teeth, produces a distinctive mentum. The light-coloured median teeth of the closely-related genus *Paratendipes* provide a reliable distinction.

Omisus fossils were only collected from Misty Lake sediments. This genus has not previously been recorded from British Columbia, but occurs throughout much of eastern North America (Oliver, 1981a; Oliver and Roussel, 1983a). The immature stages are commonly associated with humic waters (Pinder and Reiss, 1983). One species, *O. pica* Townes has been described from North America (Oliver, 1981a).

Paratendipes Kieffer (Fig. A.7d)

The lightly-pigmented median and 1st lateral mental teeth of *Paratendipes*, contrast with the 6 remaining pairs. In the fossils, the median pair of teeth and 1st lateral teeth are of a similar size, but the 2nd laterals are slightly shorter. The 3rd lateral teeth are as long, or longer than the median pair. Broad ventromental plates are separated by the 6 teeth closest to the median axis. *Paratendipes* fossils were infrequently collected, but easily recognized by the lightly-pigmented median and 1st lateral mental teeth.

This genus is widely distributed in lotic and lentic waters south of treeline (Danks, 1981; Oliver, 1981a; Oliver and Roussel, 1983a; Sublette and Sublette, 1965). *Paratendipes* remains were found in "Hermit Thrush Pond", Lost Lake, and Holocene sediments from Marion and Mike Lakes.

Chironomus Meigen (Fig. A.8a-b)

The darkly-pigmented mentum of *Chironomus* has a trifid median tooth and 6 lateral pairs. The median tooth, however, is sometimes very strongly worn in fossils from mineral sediments. The 1st laterals project about as far forward as the median tooth. Broad, fan-shaped ventromental plates are separated by most of the mentum's width. In my material, striations were indistinct, and only discernible as a band on the posterior ventromental region. The mandible includes a prominent dorsal tooth, 1 apical tooth, and 3 inner teeth. A series of radially arranged grooves was noted at the base of several

mandibles. These grooves occur only in *Baeotendipes* Kieffer, *Chironomus*, *Einfeldia* Kieffer, and *Fleuria* Kieffer (Pinder and Reiss, 1983). *Fleuria* is reported only from Europe. *Baeotendipes* and some *Einfeldia* larvae are inseparable from *Chironomus*, and may be better placed within this genus (Pinder and Reiss, 1983).

Chironomus larvae are widely-distributed, mostly in standing waters throughout the world, including the high arctic (Danks, 1981; Pinder and Reiss, 1983). Although eutrophic lakes are characterized by the great abundance of certain *Chironomus* species, a few species inhabit oligotrophic waters (Sæther, 1979). Hamilton (1965) reported *C. rempelii* Thienemann and *C. decorus* Johannsen at Marion Lake. *C. vancouveri* Michailova & Fischer (1986) was recently described from collections at Deer Lake, in "Vancouver" (presumably Burnaby). At least 7 other species have been reported in British Columbia (Cannings, 1975a, b; Sublette and Sublette, 1965).

Dicrotendipes Kieffer (Fig. A.8c)

The median mental tooth of *Dicrotendipes* head capsules may be weakly notched laterally, but is never trifid. The 1st lateral teeth are about as long as the median tooth and are closely appressed to the 2nd lateral pair. All mental teeth are darkly-pigmented. The distinctly striated ventromental plates are not much broader (laterally) than long, and have a finely crenate anterior margin in my specimens. The weakly-notched median tooth, closely appressed 1st and 2nd lateral teeth, and narrow ventromental plates provide easily recognizable features, although several genera (e.g. *Einfeldia*, *Glyptotendipes*) share a rather similar mentum.

Dicrotendipes larvae are widely-distributed, mostly in shallow lentic waters, but are rare in arctic regions (Danks, 1981; Pinder and Reiss, 1983). *Dicrotendipes lobiger* (Kieffer) is reported from Barrow, Alaska (Butler *et al.*, 1981). In Canada, *D. modestus* (Say) is reported from the southernmost arctic tundra (Moore, 1978). This species also

inhabits Marion Lake (Hamilton, 1965). *D. modestus* and *D. nervosus* Staeger are reported from the Okanagan Valley (Kangasniemi and Oliver, 1983; Sæther, 1970).

Glyptotendipes Kieffer (Fig. A.8d)

The mentum of *Glyptotendipes* fossils is similar to *Dicrotendipes* in form, but the teeth are distinctly shorter, and blunt. The ventromental plates of my specimens were very broad, tapering to acute median and lateral points. These plates are usually finely-crenate along the anterior margin and distinctly striated. Although easily distinguished from most other Canadian genera, *Einfeldia* may include very similar-looking species (Oliver and Roussel, 1983a).

In this study, *Glyptotendipes* was only collected from the surficial sediments of Alice Lake. The genus is widely-distributed in lotic and lentic waters, but has not been reported from the North American arctic (Danks, 1981; Oliver and Roussel, 1983a; Pinder and Reiss, 1983). The larvae are often associated with aquatic plants (Oliver and Roussel, 1983a). *G. barbipes* (Staeger) and *G. lobiferus* (Say) are reported from British Columbia (Sublette and Sublette, 1965).

Cladopelma Kieffer (Fig. A.9a)

The greatly enlarged teeth at the extreme lateral margins produce a distinctive mentum. This feature is also reported for *Cryptotendipes, Microchironomus* Kieffer, and some *Paracladopelma* larvae (Pinder and Reiss, 1983). The mentum is mostly darkly-pigmented, although the median tooth or teeth are often lighter in colour. The median tooth appears to be narrower than in *Cryptotendipes* larvae, and in some specimens includes a median notch. The median tooth of *Microchironomus* is distinctly trifid (Pinder and Reiss, 1983). Striations were discernible only near the posterior margin of the ventromental plates.

Larvae of *Cladopelma* are widely-distributed in North American lotic and lentic waters (Oliver, 1981a; Pinder and Reiss, 1983), but are not reported from arctic regions (Danks, 1981). Very similar larvae were collected by Hamilton (1965), and associated with adults of *Cladopelma amachaera* (Townes) (as *Harnischia amachaerus* Townes).

Cryptotendipes Lenz (Fig. A.9b)

Cryptotendipes fossils were characterized by a broad, dome-shaped median tooth, which is notched laterally to form 2 closely appressed accessory teeth. The remaining mental teeth are darker. The 2 outermost pairs of lateral teeth were closely appressed, and somewhat enlarged relative to the lateral teeth. The median tooth is distinctly broader than that of *Cladopelma*. The mentum is also more strongly-arched, having smaller extreme lateral teeth. Striae were only discernible near the posterior region of the broad ventromental plates.

Cryptotendipes fossils were collected at low-elevations in the clay-rich sediments of Deer and Lost Lakes only. The genus is probably widely-distributed in North American lotic and lentic habitats (Bass, 1986; Oliver, 1981a), but is not reported from arctic regions (Danks, 1981).

Parachironomus Lenz (Fig. A.9c-d)

Remains of *Parachironomus* have 15 or 16 weakly-pigmented mental teeth. The median tooth was largest, but most of the lateral teeth are of a similar size. The broad, fan-shaped ventromental plates were indistinctly striated, but were scalloped along the anterior margin. This scalloped ventromental margin is, to my knowledge, unique to *Parachironomus* although it is not shared by all species of the genus (Pinder and Reiss, 1983). The mandibles, which included an apical tooth, and 2 truncated inner teeth were also weakly-pigmented.

Parachironomus is widely distributed in lotic and lentic waters (Oliver, 1981a; Pinder and Reiss, 1983) but is rare in arctic habitats. The genus is reported from Toolik Lake, on the north slope of arctic Alaska (Hershey, 1985a). Several *Parachironomus* species were associated with *Myriophyllum spicatum* L. in Okanagan Valley lakes, including *P. tenuicaudata* (Malloch) (Kangasniemi and Oliver, 1983). Adults of *Parachironomus potamogeti* have been reported from Marion Lake (Hamilton, 1965: as *Harnischia potamogeti*). Hamilton (1965) also describes a larva resembling *Parachironomus* as *Harnischia galaptera*. In both instances the associations between adults and larvae were only tentative, and were probably incorrect. In this study, remains of *Parachironomus*, were found in Lost Lake, and scattered throughout late-Pleistocene and Holocene sediments of Misty Lake.

Cryptochironomus Kieffer (Fig. A.10a-b)

The distinctive concave mentum of *Cryptochironomus* fossils includes one broad, light-coloured median tooth, and 6 dark lateral pairs. The 1st lateral teeth are small, closely-appressed to the median tooth. The 5th and 6th lateral teeth are partially fused. The ventromental plates are striated and very broad, tapering to sharp median and lateral points. The mandibles include 1 long apical tooth and two darker inner teeth. The mandible and mentum of *Cryptochironomus* are very similar to *Demicryptochironomus* Lenz and may be inseparable on the basis of mandible and mentum. However, Pinder and Reiss (1983) indicate 7 lateral mental teeth to be normal for *Demicryptochironomus*.

Hamilton (1965) has collected 2 *Cryptochironomus* species at Marion Lake. The genus is known to be very widely-distributed in lotic and lentic waters, including low arctic regions (Danks, 1981; Oliver, 1981a; Pinder and Reiss, 1983). In this study, remains of *Cryptochironomus*, were found in Lost Lake, Stump Lake, and scattered throughout each of the 4 cores studied.

Stenochironomus Kieffer (Fig. A.10c)

The concave mentum of late-instar *Stenochironomus* fossils includes an even number of dark teeth, but seven distinct teeth were the norm for small remains, presumably derived from early instar larvae. Unlike other Chironomini, the ventromental plates are vestigial structures, indicated by a few indistinct striations adjacent to the mentum. Several small indistinct spines were noted on the adjacent maxillary lobe. *Stenochironomus* differs greatly in structure from all other Chironomini.

The larvae are obligate miners of vegetation, and are widely distributed in lotic and lentic waters (Oliver, 1981a; Pinder and Reiss, 1983). Borkent (1984) notes the occurrence of three species in British Columbia, *S. colei* (Malloch), *S. fuscipatellus* Borkent and *S. hilaris* (Walker). *S. fuscipatellus* is recorded as a miner in wood of *Acer macrophyllum* Pursh and *Alnus rubra* Bong. Borkent (1984) notes that *Stenochironomus* species generally occur only in angiosperm wood of trees and shrubs. In my collections, *Stenochironomus* was only recorded from Alice Lake.

Nilothauma Kieffer (Fig. A.10d-e)

The pale median mental tooth of *Nilothauma* remains is flanked by 6 pairs of lateral teeth, and is broader any lateral tooth, composing about 1/5 of the mental width. The lateral teeth are weakly-pigmented and are of a consistent size throughout. Broad, fan-shaped ventromental plates include a band of fine striae. The weakly-pigmented sickle-shaped mandible includes one apical tooth and 4 small inner teeth. Although I have been unable to discern 4 parts for the median tooth, as described by Pinder and Reiss (1983), the fossils closely resemble a *Nilothauma* species photographed by Oliver and Roussel (1983a), and *Nilothauma babiyi* (Rempel) as illustrated by both Mason (1983) and Simpson and Bode (1980).

Larvae of *Nilothauma* are widely distributed in lotic and lentic waters of North America (Bass, 1986; Mason, 1983; Oliver, 1981a; Sublette and Sublette, 1965). The genus is not known from arctic habitats (Danks, 1981; Fittkau and Reiss, 1978). *Nilothauma* remains were recovered from Lost Lake, Stump Lake, and scattered throughout late-glacial and Holocene sediments from Marion, Mike, and Misty Lakes.

Paralauterborniella Lenz (Fig. A.10f-g)

The broad, pale-coloured median tooth, which composes about 1/3 of the mental width is flanked by 6 pairs of smaller, more darkly pigmented lateral teeth. The mentum is flanked by two very large, broad, and distinctly striated ventromental plates. Mandibles include an apical tooth, and 3 inner teeth. Although the mentum of *Paralauterborniella* resembles *Nilothauma*, the median tooth is much broader. Mandibles of this genus include 3 rather than 4 inner mandibular teeth (Pinder and Reiss, 1983), and are not strongly-arched.

Paralauterborniella is widely-distributed, usually in shallow lentic waters, throughout North America south of treeline (Danks, 1981; Oliver, 1981a; Pinder and Reiss, 1983; Sublette and Sublette, 1965). In my collections, this genus was rare, collected from clay-rich sediments of Deer and Lost Lakes only. *P. nigrohalterale* (Malloch) is reported from 2 Okanagan Valley lakes (Sæther and McLean, 1972).

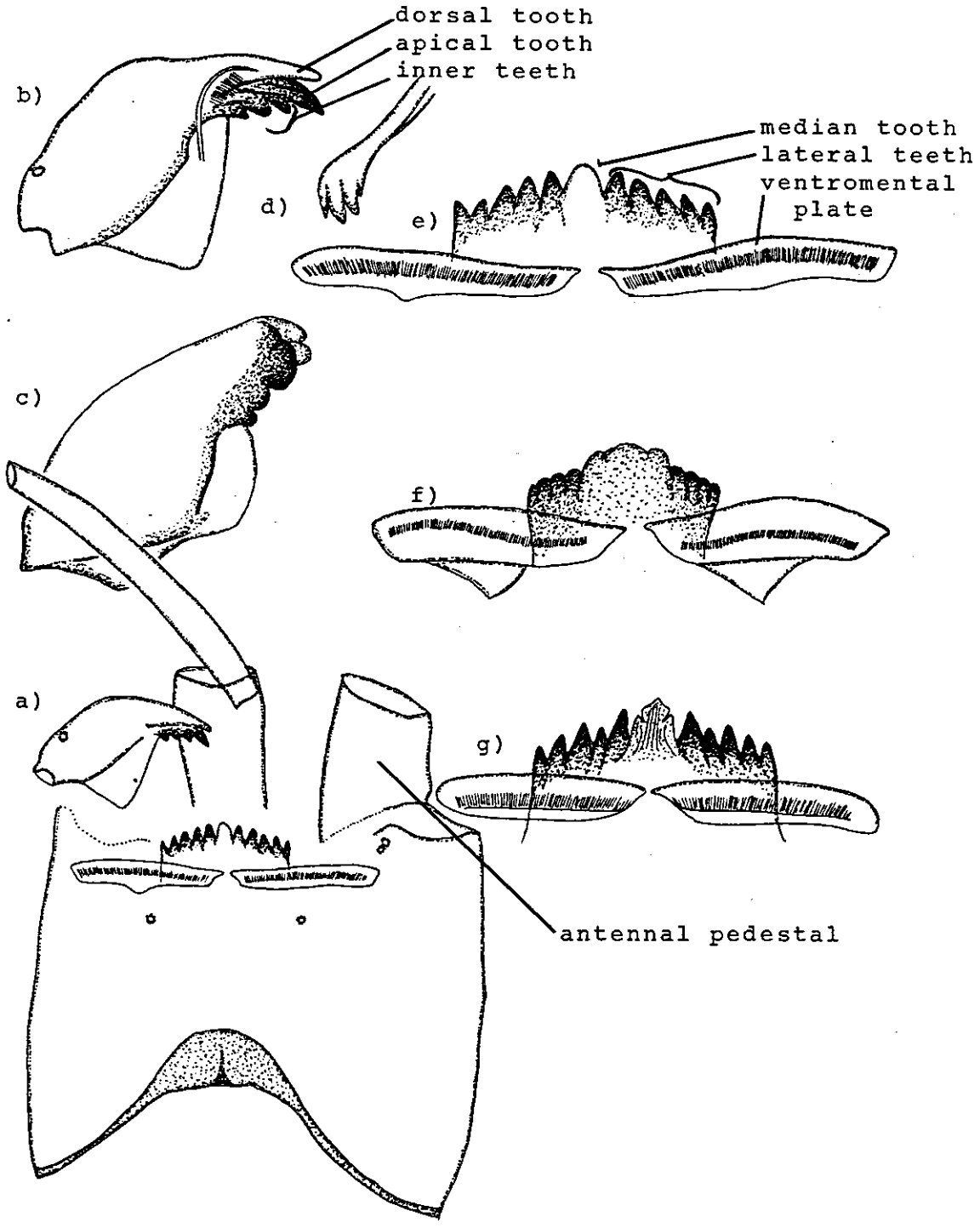

Figure A.3 Chironominae: Tanytarsini: *Tanytarsus* v.d.Wulp s.lat.: a) head capsule (210X), b) mandible (360X), c) mandible (610X), d) premandible (340X), e) mentum (410X), f) mentum (760X), g) mentum (450X)

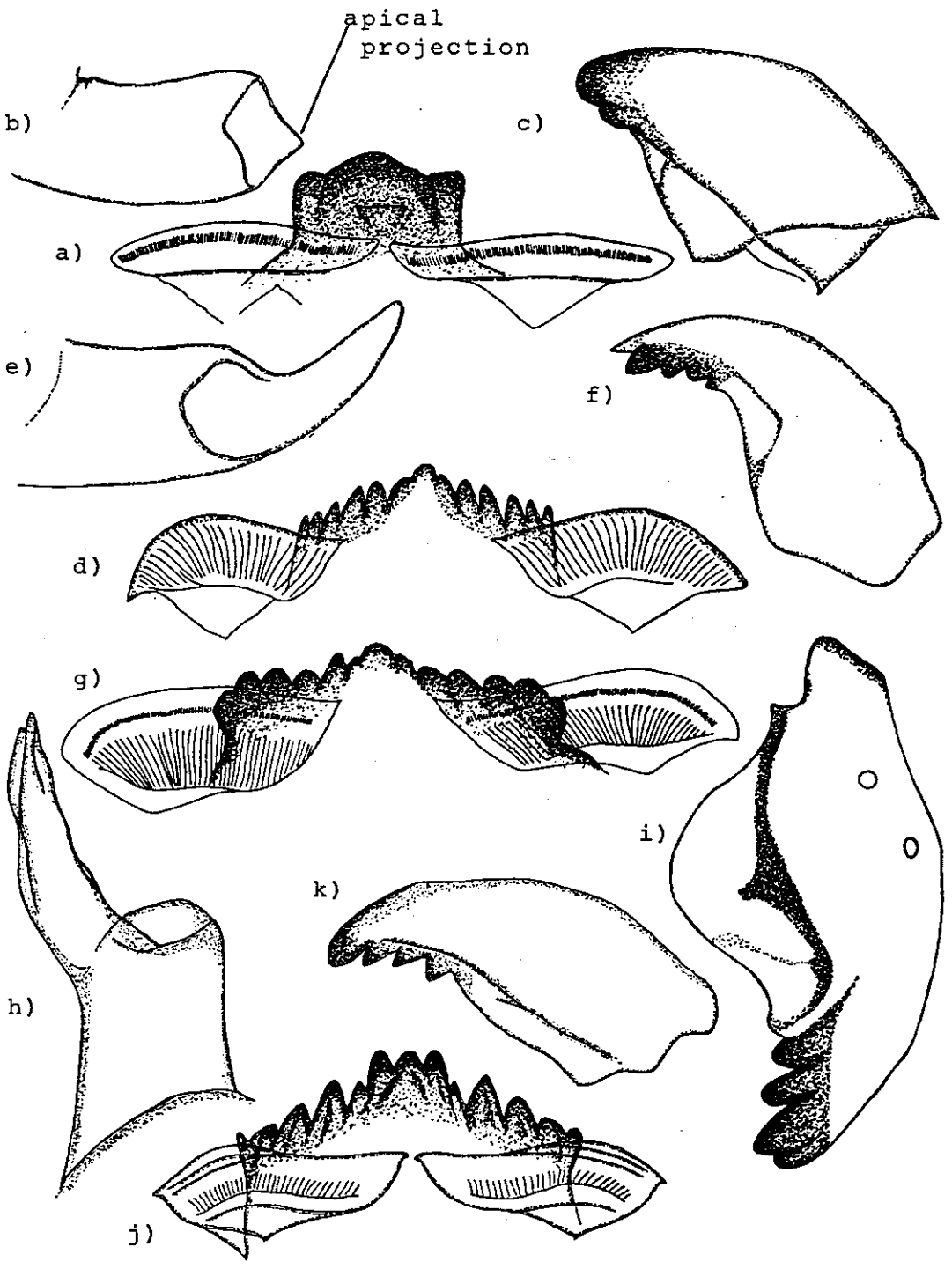

Figure A.4 *Corynocera* nr. *ambigua* Zetterstedt (420X): a) mentum, b) antennal pedestal, c) mandible - *Stempellinella* Brundin (610X): d) mentum, e) antennal pedestal, f) mandible - Tanytarsini sp.A (590X): g) mentum, h) antennal pedestal, i) mandible - Pseudochironomini: *Pseudochironomus* Malloch (560X): j) mentum, k) mandible

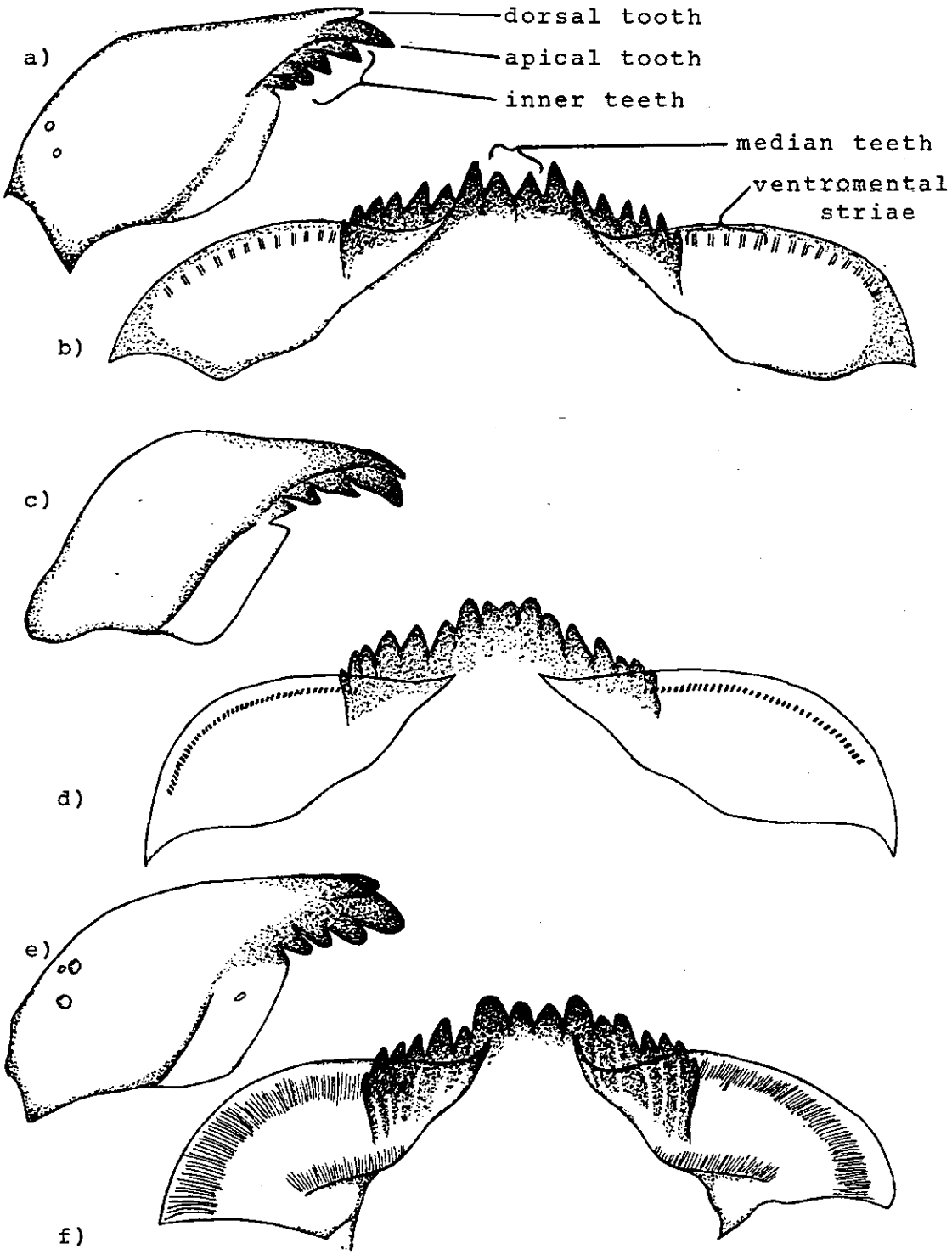

Figure A.5 Chironominae: Chironomini: *Sergentia* Kieffer (520X): a) mandible, b) mentum - *Stictochironomus* Kieffer (350X): c) mandible, d) mentum - *Tribelos* Townes (320X): e) mandible, f) mentum

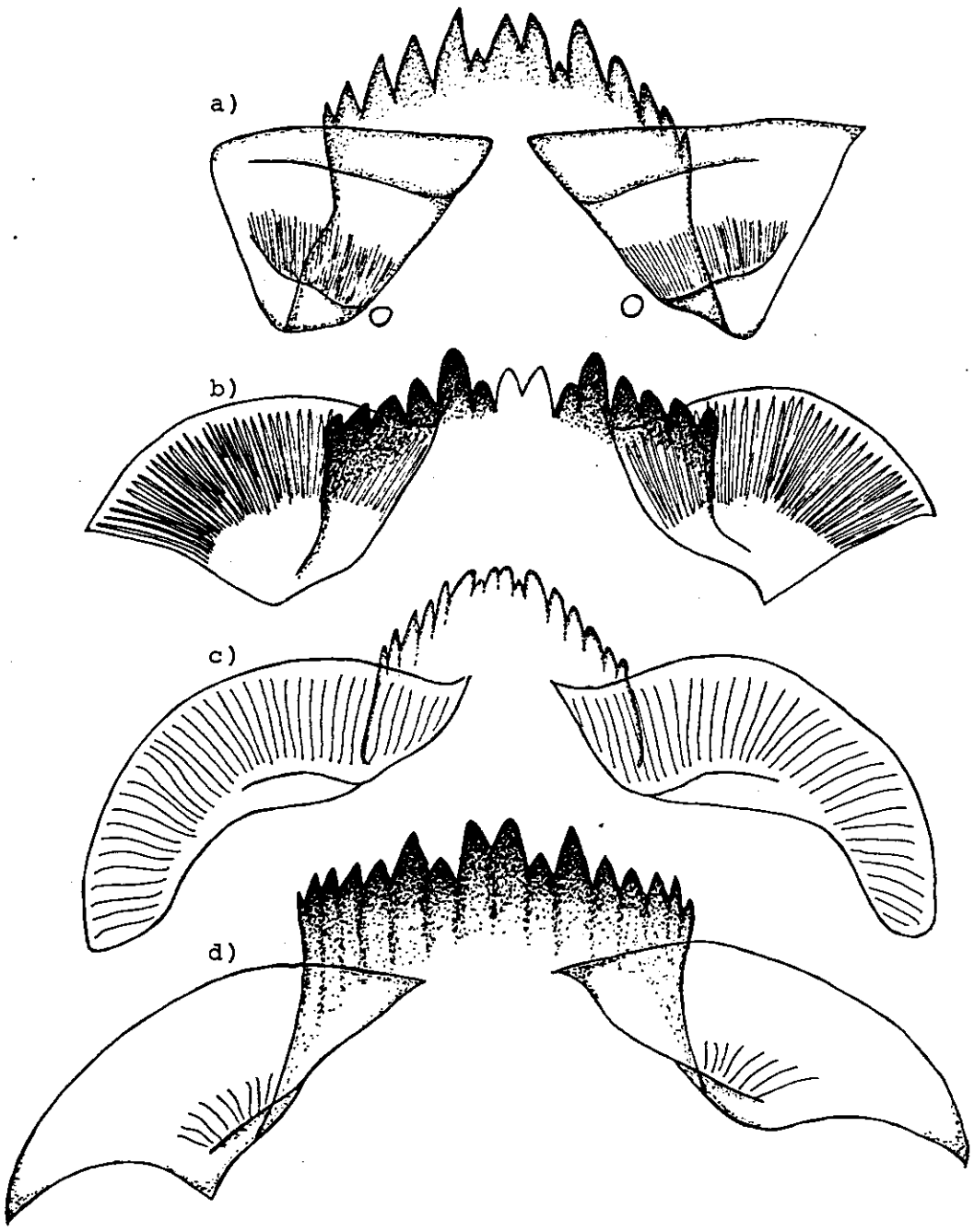

Figure A.6 a) *Lauterborniella* Thienemann & Bause/*Zavreliella* Kieffer mentum (850X), b) *Microtendipes* Kieffer mentum (630X), c) *Pagastiella* cf. *ostansa* Webb mentum (760X), d) *Polypedilum* Kieffer mentum (970X)

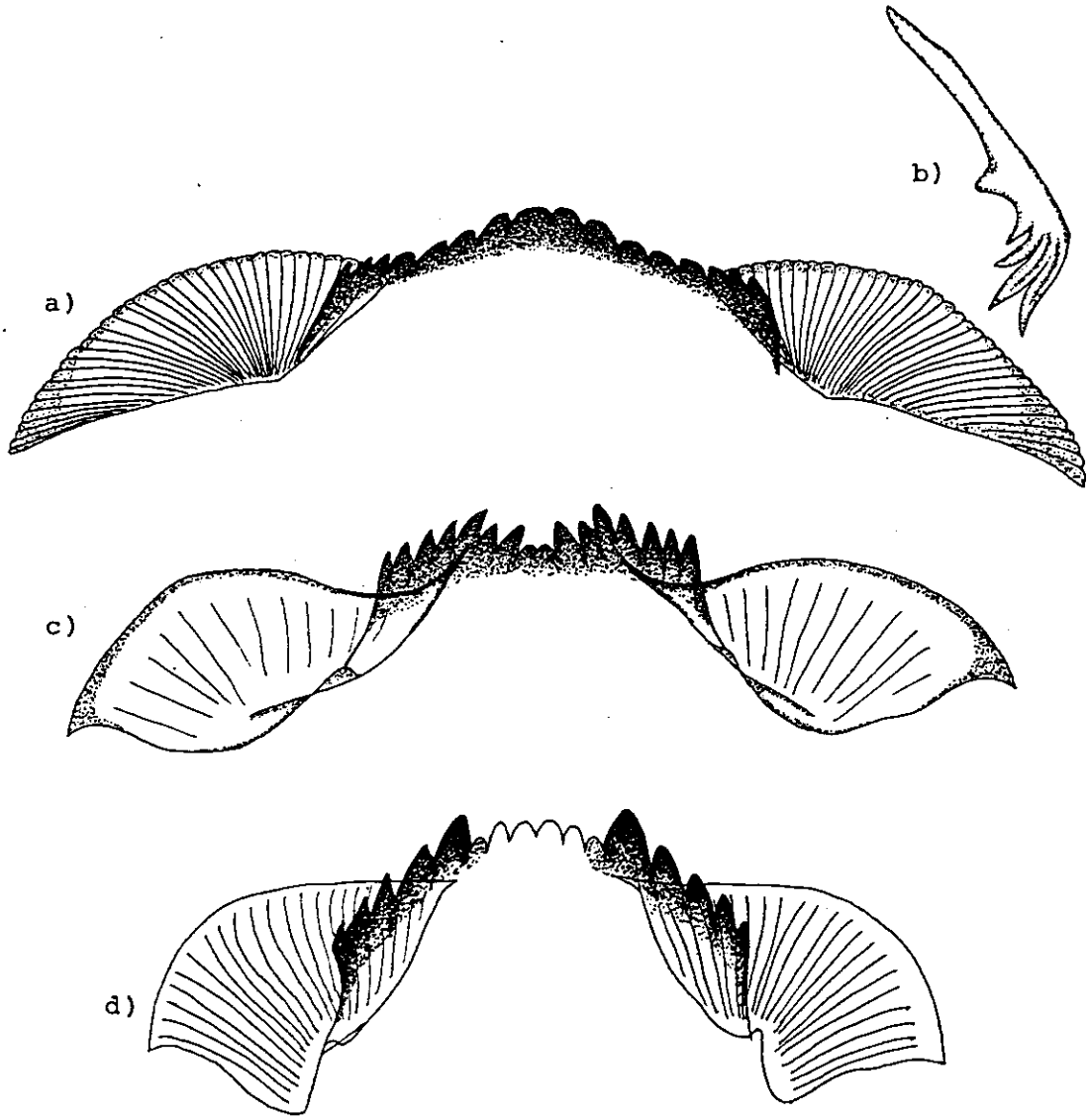

Figure A.7 *Cyphomella* Sæther/*Harnischia* Kieffer/*Paracladopelma* Harnisch (700X): a) mentum, b) premandible - *Omisus* Townes (920X): c) mentum - *Paratendipes* Kieffer (1100X): d) mentum

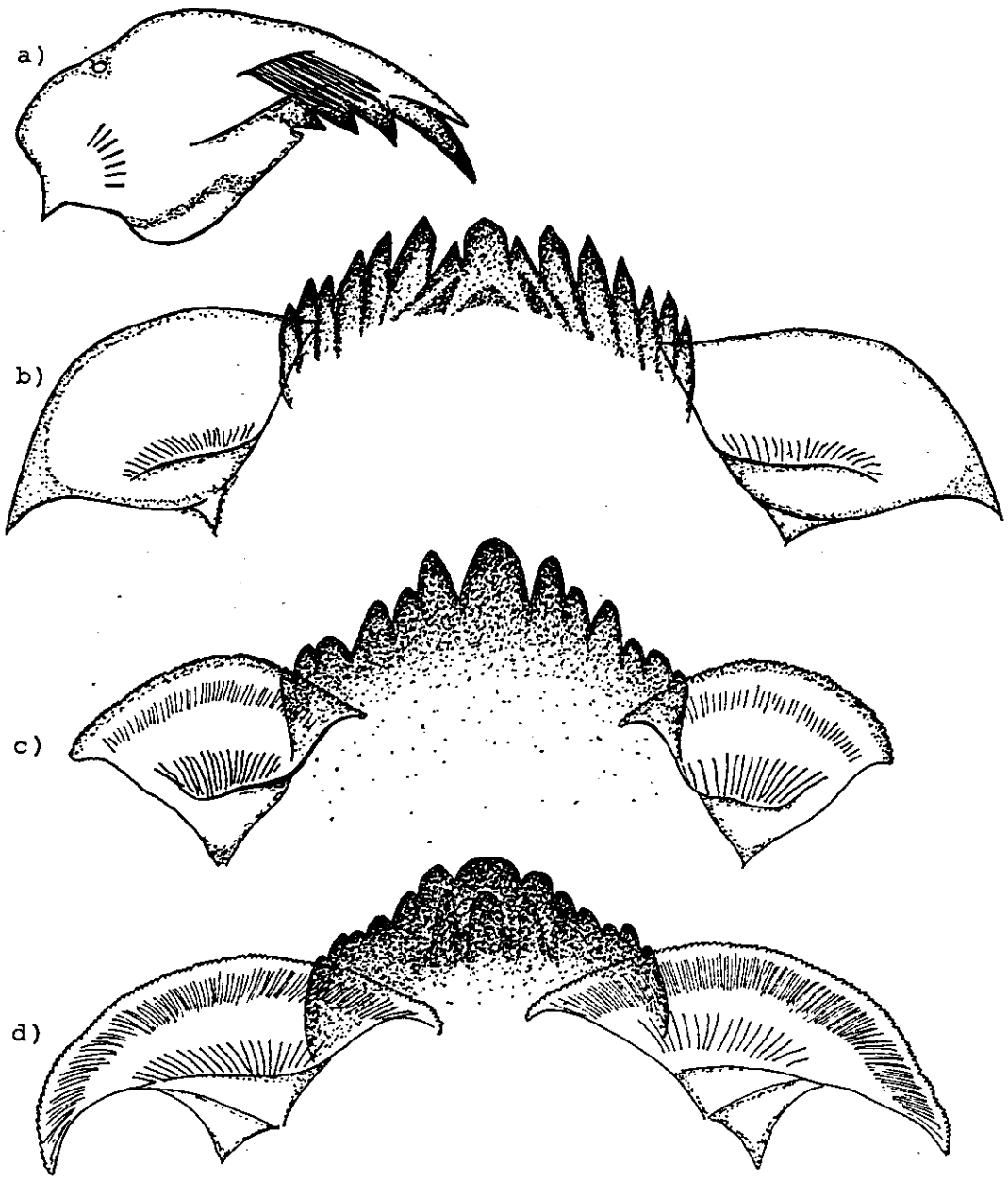

Figure A.8 *Chironomus* Meigen (520X): a) mandible, b) mentum – *Dicrotendipes* Kieffer (400X): c) mentum – *Glyptotendipes* Kieffer (230X): d) mentum

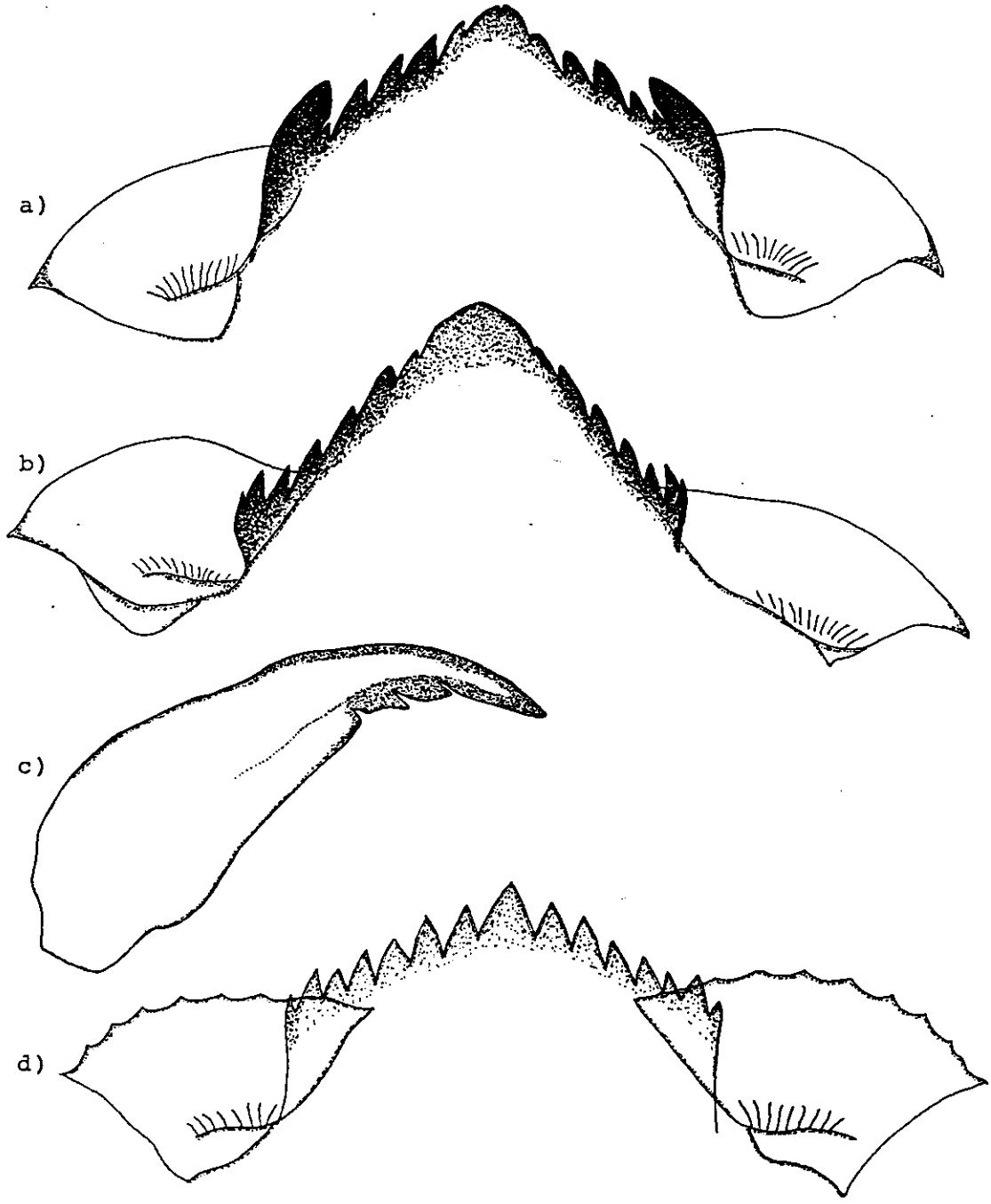

Figure A.9 *Cladopelma* Kieffer (940X): a) mentum - *Cryptotendipes* Lenz (950X): b) mentum - *Parachironomus* Lenz (940X): c) mandible, d) mentum

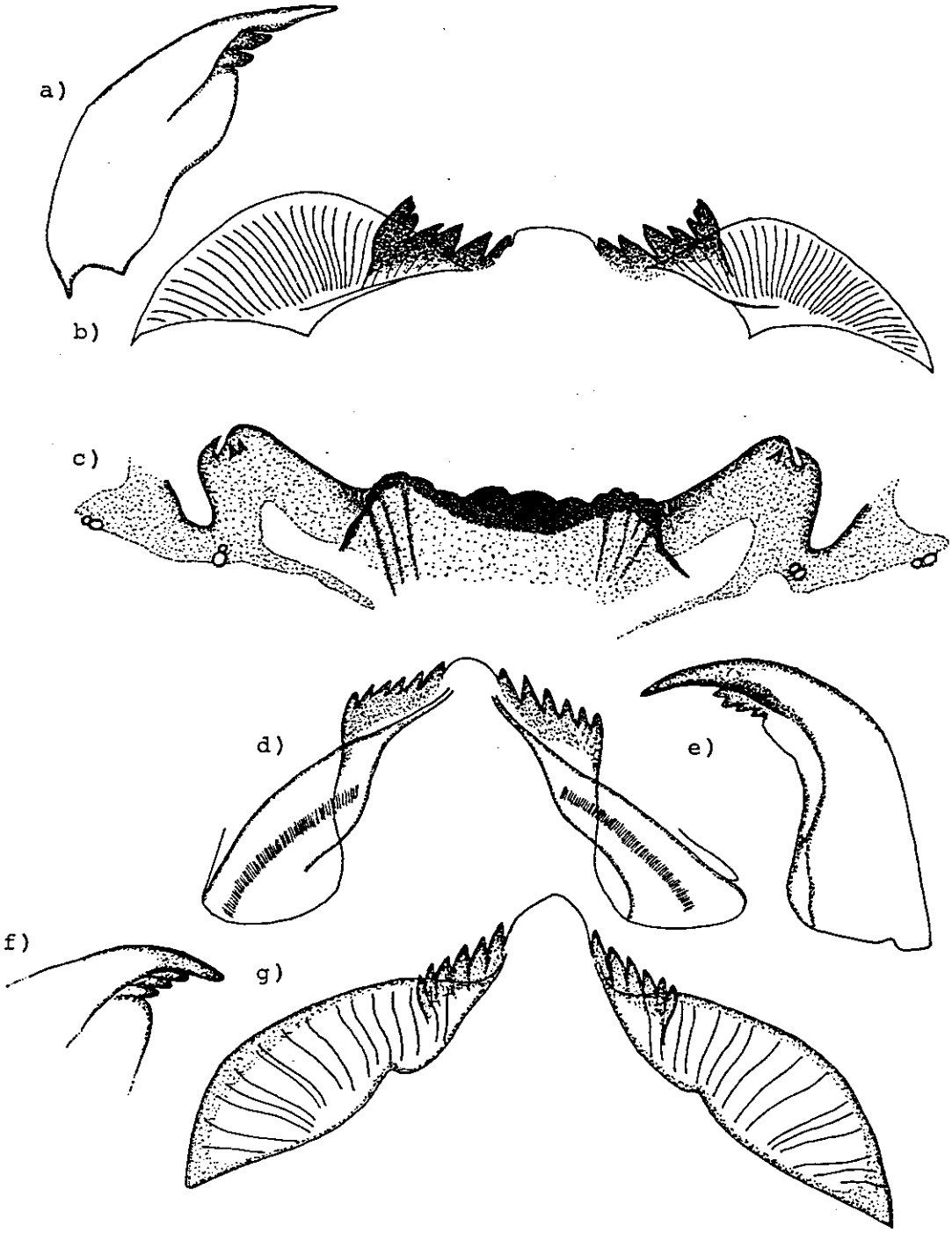

Figure A.10 *Cryptochironomus* Kieffer (870X): a) mandible, b) mentum – *Stenochironomus* Kieffer (370X): c) mentum – *Nilothauma* Kieffer (640X): d) mentum, e) mandible – *Paralauterborniella* Lenz (510X): f) mandible, g) mentum

Subfamily Podonominae

Boreochlus Edwards (Fig. A.11a–b)

A single Podonominae fossil type was discovered, with 15 mental teeth of similar size. The submental setae are separated by a distance about equal to the mental width. The mandible is more distinctive with 8 teeth, including 1 dorsal tooth, 1 large apical tooth, and 6 inner teeth. The second inner tooth is distinctly shorter than the adjacent mandibular teeth.

Although the mentum is similar to that of some Orthocladiinae, the mandible is distinctive among chironomids, apart from Podonominae. The number and arrangement of teeth on the mentum and mandible, as described above, satisfy the generic diagnoses of both *Boreochlus* and *Paraboreochlus* Thienemann (Brundin, 1983). These genera cannot be separated on the basis of labrum, mandible, or mentum (Brundin, 1983).

Boreochlus is reported from much of southern Canada, including British Columbia (Oliver and Roussel, 1983a). Three species (*B. gracilistylus* Brundin, *B. persimilis* (Johannsen), *B. sinuaticornis* Brundin) are reported from adjacent regions of Washington State (Mount Baker area, Olympic Peninsula) (Wirth and Sublette, 1970). One undescribed Nearctic *Paraboreochlus* species is known from the Appalachians (Beck, 1980; Brundin, 1983; Coffman and Ferrington, 1984). Larvae of both genera occur in cool springs and streams among mosses (Brundin, 1983; Oliver and Roussel, 1983a). *Boreochlus* remains were recovered from Black Tusk Lake, and Holocene sediments from Mike and Misty Lakes.

Subfamily Diamesinae

Diamesa Meigen? (Fig. A.11c)

Fossils similar to *Diamesa* were rare in this study, and separated from some Orthocladiinae with difficulty. The mentum is broad, bearing numerous pairs of similar-sized teeth (9 pairs in the example illustrated). Ventromental plates are poorly-developed. The submental setae are near the mentum. Some Orthocladiinae genera (e.g. *Orthocladius*) may include species with characteristics similar to the fossils.

Diamesa are common in cool to cold flowing water and springs, occurring even in the high arctic (Danks, 1981; Oliver, 1983). Four species are known from British Columbia, with 3 additional *Diamesa* species being known from the Mount Baker area of Washington State, U.S.A. (Hansen and Cook, 1976). Remains of *Diamesa*? fossils were found only in "Coleman Pond" and Goldie Lake.

Protanypus Kieffer (Fig. A.11d)

Although the broad, relatively light-coloured median portion of the mentum may be subdivided into several units, creating broad tooth-like divisions, sharp strongly-sclerotized teeth (2 pairs) are confined to the extreme lateral margins of the mentum. Numerous setae are distributed across the head capsule. These characteristics readily distinguish *Protanypus* from all other chironomids.

The larvae occur in cold waters of oligotrophic lakes. The genus is reported from much of Canada, including deep, arctic waters (Oliver, 1964, 1981a; Sæther, 1975c), but only from Washington State, and the Great Lakes region of the United States (Oliver, 1981a; Sæther, 1975c; Wiederholm, 1976; Winnell and White, 1985). A similar northern and high elevation distribution is evident in Europe (Fittkau and Reiss, 1978). The genus

is represented by *Protanypus* sp.A at Marion Lake today, but *P. hamiltoni* Sæther is reported elsewhere in British Columbia (Sæther, 1975c).

Pagastia Oliver (Fig. A.12a–b)

In *Pagastia* fossils, a broad light-coloured median tooth separates about 5 pairs of dark lateral teeth. The structure of the mentum is similar to a few Orthocladiinae, and some other Diamesinae. However, the broad ventromental plates overlap the lateral teeth, and the submental setae are distant from the mentum, placed close to the posterior margin of the head capsule. Although no median "ridge-like projections" (Oliver, 1983) were discernible on fossil mental plates, these may have been lost through abrasion.

Pagastia larvae are rheophilous, known from much of northern and western North America, south of treeline (Oliver and Roussel, 1982). I have collected larvae from an upper subalpine stream in the Mount Baker area of Washington State, U.S.A. Oliver and Roussel (1982) report three species in western North America. *Pagastia* was noted in sediments from Hayes, Helm, and Mimulus Lakes, during my studies.

Potthastia Kieffer? (Fig. A.12c–d)

Several early instar fossils were similar to *Potthastia gaedii*. A broad light-coloured median tooth separates about 5 (perhaps more) pairs of lateral mental teeth in the fossil material. The ventromental plates are well-developed, extending beyond the lateral dorsomental teeth, as also described for *Pagastia*. The submental setae are situated close to the mentum.

The above characteristics differ somewhat from the *Potthastia gaedii* (Meigen) group as described by Oliver (1983). Some Orthocladiinae genera (e.g. *Parakiefferiella* Thienemann) may include species with similar structure, but the broad ventromental plates of the fossils are more similar to those of some Diamesinae.

Potthastia has been reported throughout much of northern Canada, south of treeline (Oliver, 1981a; Oliver and Roussel, 1983a). The *Potthastia longimana* Kieffer group occurs in Lake Okanagan (Sæther, 1970). The larvae of *Potthastia gaedii* are rheophilous (Oliver, 1983). *Potthastia*? was only collected from "Coleman Pond".

Pseudodiamesa Goetghebuer (Fig. A.12e–f)

The median tooth and 1st lateral teeth of *Pseudodiamesa* are subequal, and separate the broad ventromental plates. The ventromental plates wholly or partially conceal the remaining mental teeth. All components of the mentum and ventromental plates are dark (black in the final larval instars). The anterior origin of ventromental plates is apparent at the outer margin of the three median teeth. The 2nd lateral teeth are somewhat appressed to the 1st lateral teeth. The 6th lateral teeth are distinctly longer than adjacent pairs. Submental setae are situated close to the mentum. Mandibles have one prominent apical tooth and four inner teeth. The combined characteristics of the mentum, outlined above, appear to be unique to *Pseudodiamesa*.

The larvae occur in both cold lotic and lentic environments, and are mostly restricted to arctic and alpine habitats (Danks, 1981; Downes, 1964; Oliver, 1983; Oliver and Roussel, 1983a), although Beck (1980) reports one species from Tennessee. *Pseudodiamesa branickii* (Nowicki) and *P. pertinax* (Garrett) are reported from British Columbia (Sublette and Sublette, 1965). In this study, remains of *Pseudodiamesa*, were found in surface sediments from "Coleman Pond", Helm Lake, and Mimulus Lake, and Marion Lake's late–Pleistocene sediments.

Subfamily Orthocladiinae

Brillia Kieffer/*Euryhapsis* Oliver (Fig. A.13a–b)

The submental setae of *Brillia* and *Euryhapsis* larvae are set far back from the mentum, midway between the mentum and the posterior margin of the head capsule. *Pagastia* (Diamesinae) is similar in this regard. Among Orthocladiinae this feature is reported only for *Brillia*, *Euryhapsis*, *Lopescladius* Oliveira, and *Paralimnophyes* Brundin (Cranston *et al.*, 1983). In some species of *Brillia* and *Euryhapsis* the median teeth are separated by a minute third tooth, as illustrated. (Cranston *et al.*, 1983). The outermost 2 pairs of lateral teeth are closely appressed. The ventromental plates are weakly–developed. Although a minute ventromental beard distinguishes the known larvae of *Euryhapsis* (Cranston *et al.*, 1983), this character may be unreliable if the setae are not consistently preserved.

Brillia larvae are often associated with vegetation in both lotic and lentic habitats. *Euryhapsis* is reported from lotic environments (Cranston *et al.*, 1983). Both genera occur north of North American treeline (D.R. Oliver, pers. comm.). *Brillia* is otherwise widely–distributed in North America, but *Euryhapsis* is reported only from the west (Oliver, 1981b). *Brillia retifinis* Sæther is reported from Marion Lake (Oliver and Roussel, 1983b).

Corynoneura Winnertz/*Thienemanniella* Kieffer (Fig. A.13c–d)

The small teeth and steeply sloping margins of the mentum in *Corynoneura* and *Thienemanniella* are distinctive features for fossil identification. The mentum may include 12 or 13 teeth. In the fossil material, the median tooth and the 1st lateral teeth projected distinctly beyond the remaining mental teeth. The mentum was light–coloured with weak sclerotization bands. Ventromental plates are poorly developed. The submental

setae are situated near the mentum. Antennal characteristics which allow separation of *Corynoneura* and *Thienemanniella* (Cranston *et al.*, 1983) were seldom available in fossils. Two fossils with intact antennae were distinguished as *Thienemanniella*.

Although *Corynoneura* occurs in both lotic and lentic habitats, *Thienemanniella* is reported only from lotic environments (Cranston *et al.*, 1983). Both genera are widely-distributed throughout the world, and are reported from the Canadian high arctic (Cranston *et al.*, 1983; Danks, 1981).

Smittia Holmgren/*Pseudosmittia* Goetghebuer? group (Fig. A.14a-b)

Fossil head capsules resembling *Smittia* or *Pseudosmittia* were found infrequently and were not readily separable from several other Orthocladiinae genera. Although a considerable diversity of head capsule structure was noted, only one example has been illustrated. The mentum of head capsules assigned to this group had a single, rather broad median tooth, separating 4 or 5 lateral pairs. A medium to dark-brown pigmentation characterized the mental teeth. The ventromental plates varied considerably in size, often being poorly developed. Although mandibles were seldom retained with the fossils, those mandibles examined were similar to those of most Orthocladiinae genera, having 1 apical tooth and 3 distinct inner teeth. The submental setae are set close to the mentum. Fossils of this type may belong to several Orthocladiinae genera, including *Camptocladius* v.d.Wulp, *Cardiocladius* Kieffer, *Chaetocladius* Kieffer, and *Georthocladius* Strenzke, as well as *Pseudosmittia* and *Smittia*.

Those taxa listed are frequently recorded from terrestrial, semi-terrestrial, and lotic environments. Since many of these fossils must have been carried into lakes via streams, or eroded from adjacent soils, mouthparts other than the mentum were seldom retained within the head capsules. The composite distribution of these genera spans most of the world, including the high arctic (Cranston *et al.*, 1983; Danks, 1981).

Cricotopus v.d.Wulp/*Orthocladius* v.d.Wulp/*Paratrichocladius* Santos Abreu (Fig. A.14c,d)

Cricotopus and *Orthocladius* are large genera with diverse mental characteristics. Only one example is illustrated. These genera and *Paratrichocladius* cannot be reliably distinguished as larval fossils. The remains, in this study, were distinguished as having a single median tooth separating 6 lateral pairs. The anterolateral margins of the mentum slope steeply backwards. Ventromental plates are poorly-developed. Submental setae are close to the mentum. In some instances separation of the above taxa from other genera (e.g. *Boreochlus, Diamesa*) could be difficult on characters of the mentum alone.

The 3 genera (*Cricotopus, Orthocladius, Paratrichocladius*) are very widely distributed, occurring in all types of freshwater, with a composite distribution including most of the world (Cranston *et al.*, 1983). Some *Orthocladius* occur in semi-terrestrial habitats (Cranston *et al.*, 1983). *Cricotopus tricinctus* Meigen and *Orthocladius carlatus* (Roback) have been reported from Marion Lake (Hamilton, 1965; Soponis, 1977). Many other species undoubtedly occur in the study areas.

Orthocladius (*Symposiocladius*) *lignicola* Kieffer (Fig. A.14e)

The mentum of *O. lignicola* consists of a broad, strongly-arched median region, separating two pairs of rounded, extreme lateral teeth. The mentum is dark brown to black, being very heavily sclerotized. Ventromental plates are weakly developed. Fossil head capsules of this distinctive species were rare, and invariably had split along the median axis of the mentum. Although this species had been placed in the monospecific genus *Symposiocladius* Cranston (1982a), the pupae and adults are not distinct from *Orthocladius* (Cranston and Oliver, *in press.*; D.R. Oliver, pers. comm.).

According to Cranston *et al.* (1983), the larvae burrow in hardwood submersed in flowing water. This species is widely distributed south of tree-line in both North America

and Europe (Cranston, 1982a; Cranston *et al.*, 1983). In this study, remains of *O. lignicola* were found in Holocene sediments from Hippa Lake, and in late-glacial and Holocene sediments from Marion Lake.

Paracladius Hirvenoja (Fig. A.15a-c)

Head capsules of *Paracladius* were common in recent sediments of high elevation lakes. The mentum is weakly arched, with a broad dome-shaped median tooth separating 6 pairs of lateral teeth. The lateral teeth are darker than the median region. Well developed ventromental plates overlap the lateral teeth. The premandible, retained in some fossil head capsules, had a distinct apical notch. These characteristics correspond closely to the published diagnosis of *Paracladius* (Cranston *et al.*, 1983). *Paracladius* larvae had previously been reported from several of my Banff National Park study sites (Mayhood and Anderson, 1976).

Paracladius is known from lakes throughout arctic North America, from high elevation lakes of the Canadian Cordillera, and the profundal of deep temperate lakes in Canada (Danks, 1981; Hare, 1976; Mayhood and Anderson, 1976; Oliver, 1976; Sæther and McLean, 1972), but has only been reported from the Great Lakes and Cordilleran regions of the United States (Coffman and Ferrington, 1984; Oliver, 1981a; Winnell and White, 1985). Older reports are frequently cited as *Cricotopus* (*Paratrichocladius*) cf. *alpicola* (Zetterstedt). The larvae have also been reported from slowly flowing water (Oliver and Roussel, 1983a).

Stilocladius Rossaro (Fig. A.15d)

Fossil material of *Stilocladius* was distinguished by a strongly-arched mentum, and very broad ventromental plates. The broad, light-coloured median tooth may be flanked by 2 small accessory teeth in my material, but these teeth were difficult to resolve. Five

subsequent pairs of teeth complete the mentum. The 1st pair is situated at the forward origin of the ventromental plates. The four remaining pairs of lateral teeth are more darkly pigmented. The great breadth of the ventromental plates is an especially distinctive feature. Although no ventromental beard was noted, these setae are rarely preserved.

Stilocladius has previously been recorded only from Carolina streams and Cape Breton Island in North America, and in Europe only from springs and high-elevation streams in the Italian Alps and Apennines (Coffman *et al.*, 1986; Oliver, pers. comm.; Sæther, 1982). The European species, *Stilocladius montanus* Rossaro is a cold stenotherm found in water of 4 to 10° C (Rossaro, 1984). Although confined to cold springs in summer, it occurs in larger streams during winter.

This is the first record for western North America. An undescribed species probably inhabits the western Cordillera. *Stilocladius* remains were collected at "Aqua Incognito", and in late-glacial/early Holocene sediments from Marion and Mike Lakes.

Parakiefferiella? cf. *triquetra* (Chernovskii) (Fig. A.16a-b)

The fossil mentum is strongly-arched with a very large, unpigmented median tooth. Six pairs of small, dark lateral teeth, and well-developed ventromental plates complete the mentum. The lateral teeth are all of similar size. The ventromental plates have a convex lateral margin, which may completely overlap some lateral teeth. The submental setae are separated by a distance approximately equal to the width of the median tooth. The mandible has one long, light-coloured apical tooth, and three inner teeth.

A very similar larva has been described by Pankratova (1970) as *Paratrichocladius triquetra* (Chenovskii), with 5, rather than 6, pairs of lateral teeth. This generic placement is incorrect. The head capsules also correspond to larvae from Marion Lake described by Hamilton (1965). He had tentatively associated the larva with adults of *Parakiefferiella*

nigra Brundin. Although I have previously accepted this association (Walker and Mathewes, 1987a), a more conservative approach seems justified. The larvae have also been reported from Kalamalka Lake in the Okanagan Valley (Sæther and McLean, 1972: as "Parakiefferiella nigra"). Hare (1975) reports "?*Paratrichocladius* sp. *triquetra* type" from Lake Huron, noting that it may be a *Paracladius* species.

Parakiefferiella cf. *bathophila* (Kieffer) (Fig. A.16c)

The median tooth of the fossil head capsules has a single broad median tooth, flanked by a pair of inconspicuous accessory teeth. The median tooth and accessory teeth are lighter in colour than the remaining teeth of the mentum. The 5 remaining pairs of lateral teeth are all similar to each other in size. The transparent ventromental plates are moderately developed with a convex lateral margin, but seldom completely overlap any lateral teeth. Although some *Psectrocladius* may have a similar mentum, the convex lateral ventromental margins are not common in *Psectrocladius*. The shape of the mentum resembles that of *Parakiefferiella bathophila*, as illustrated by Cranston (1982b), although any median "double hump" was inconspicuous and usually absent. Although neither the mandible nor premandible have been illustrated, a simple premandible was noted with several fossils. Mandibles include a long apical tooth and 3 inner teeth.

I have previously reported this taxon as *Parakiefferiella* sp.B (Walker and Mathewes, 1987a). Although fossil head capsules do occur in surface sediments of Marion Lake, Hamilton (1965) has not reported similar larvae. Hamilton (1965) did collect adults of *Parakiefferiella coronata* (Edwards) and *P. nigra* at Marion Lake. These adults were tentatively associated by Hamilton (1965) with larvae of *Parakiefferiella*? cf. *triquetra* (this study) and *Nanocladius* sp. near *balticus* (Palmén) (Sæther, 1977). Cranston (1982b) described the median tooth of *P. coronata* as "broad and domed", although the larva he described was not reared. *Parakiefferiella* near *bathophila* is listed with Sæther's (1970)

exuviae and imagines for Lake Okanagan. Nearctic *Parakiefferiella* species occur in some lotic but mostly lentic habitats in northern and western North America (Coffman and Ferrington, 1984; Oliver, 1981a; Oliver and Roussel, 1983a).

Parakiefferiella sp.A (Fig. A.16d–g)

A broad dark median tooth is flanked by 6 pairs of lateral mental teeth in this fossil. The most distinctive feature is the greatly reduced 2nd lateral pair. The 2nd lateral teeth are usually closely appressed to the 1st lateral teeth. The 3rd, 4th, and 5th lateral teeth are usually of similar size to the 1st lateral pair. The central mental teeth of many fossils from clay sediments were greatly worn. Little evidence of the 1st or 2nd lateral teeth is then apparent. The ventromental plates are moderately well–developed with a convex lateral margin. The mandible includes one rather short apical tooth, and 3 inner teeth. The premandible is distinctly bifid.

Larvae of this type were first described by Sæther (1970) from the profundal of Lake Okanagan as "genus near *Trissocladius*". Hare (1976) reports this larva in Parry Sound, Lake Huron. *Parakiefferiella* sp.A occurs in lower subalpine to alpine lakes of the Canadian Rocky Mountain national parks (D.B. Donald, pers. comm.; Hare, 1976; Mayhood and Anderson, 1976; this study). Collections are available from Manicouagan Reservoir, Québec, and the Alaskan north slope (D.R. Oliver, pers. comm.) and possibly Hazen Camp, Northwest Territories. Warwick (pers. comm.) believes that it may also correspond to his "genus near *Heterotrissocladius*" (Warwick, 1980a, b). A photograph of *Parakiefferiella* sp.A is provided by Oliver and Roussel (1983a: fig. 368).

Psectrocladius subg. (*Monopsectrocladius* Laville) (Fig. A.17a)

One broad median tooth separates 5 pairs of lateral teeth in this group. The median tooth is slightly more weakly pigmented than the remaining teeth. The lateral

teeth are arranged in a consistent order of decreasing size. The well-developed ventromental plates have straight or weakly concave anterolateral margins, and may completely overlap one to several lateral teeth. Evidence of a ventromental beard is visible in some remains. The premandible is undivided.

These remains are similar to *P.* (*Monopsectrocladius*) sp. near *calcaratus* Edwards, as illustrated by Cranston *et al.* (1983). *P. calcaratus* is a lentic species reported from Canada, and much of northern Europe (Fittkau and Reiss, 1978; Sæther, 1969), including the low arctic (Oliver, 1964). I have collected similar larvae from bog lakes in New Brunswick and Nova Scotia (Walker *et al.*, 1985). Two larval types from Marion Lake, *Psectrocladius* sp.A and *P.* sp.B (Hamilton, 1965), are similar to my material. Hamilton (1965) has reared *Psectrocladius* sp.A.

other *Psectrocladius* Kieffer (Fig. A.17b–e)

Other fossil material placed with *Psectrocladius* usually had 2 distinct median teeth which were often lightly pigmented, and never had accessory teeth. Five subsequent pairs of dark lateral teeth were arranged in an order of consistently decreasing size. Anterolateral margins of the ventromental plates are usually nearly straight, or weakly concave. Similar plates occur in few other Orthocladiinae genera. The ventromental beard was rarely observed and probably is not consistently preserved. The mandible includes 1 apical tooth and 3 dark inner teeth. The premandible when present was simple. Although most fossils clearly belong to subgenus *Psectrocladius*, rare fossil remains belonging either to *P.* (*Allopsectrocladius* Wülker), or *P.* (*Mesopsectrocladius* Laville), were occasionally found, but not differentiated.

Larvae of these subgenera are common in lakes, but some also occur in temporary ponds, bog pools, and lotic waters (Fittkau and Reiss, 1978). The genus is widely distributed throughout most of the world, including shallow high arctic lakes and ponds

(Cranston *et al.* 1983, Danks, 1981). For Marion Lake, Hamilton (1965) illustrates larvae of *Psectrocladius* s.str., and one larva of either *Allopsectrocladius* or *Mesopsectrocladius.*

Heterotrissocladius Spärck (Fig. A.18a–b)

The broad median pair of teeth in *Heterotrissocladius* fossils are either simple, or flanked by small accessory teeth, similar to those illustrated for *Rheocricotopus* and *Zalutschia.* The 5 pairs of lateral teeth are arranged in a consistent order of decreasing size laterally. In some instances, fossils from clay sediments were strongly worn leaving little indication of the first 3 lateral pairs. Although such a mentum is superficially similar to *Orthocladius lignicola,* the ventromental plates are well–developed with a convex lateral margin. The teeth are always dark, and are black in some final instar head capsules. Although transparent in early instars, the ventromental plates may also be strongly–pigmented in more mature larvae. A light–coloured, weakly–sclerotized region is often evident along the median axis of the submentum (D.R. Oliver, pers. comm.). Head capsules frequently split into 2 equal halves along this zone of weakness.

Although *H. marcidus* (Walker) may occur in relatively warm waters, the larvae of all species are cold stenotherms (Sæther, 1975b). The genus is Holarctic, occurring in lotic and lentic environments, including deep, high–arctic lakes (Oliver, 1976; Sæther, 1975b). In the warmer regions of Europe and North America, the genus is increasingly restricted to cold streams and the deep profundal waters of large lakes (Sæther, 1975b). Few North American records exist outside of Canada and the northern United States (Sæther, 1975b). *H. latilaminus* Sæther and *H. marcidus* occur at Marion Lake today (Sæther, 1975b).

Hydrobaenus Fries (Fig. A.18c)

The median and 1st lateral mental teeth of *Hydrobaenus* fossils are weakly–pigmented and are all of similar length. The two median teeth are broad,

rounded and separated by a median notch. The 1st lateral teeth are narrower, about as long as the median teeth in the fossils, but could be considered accessories to the median pair. The remaining 5 lateral pairs are slightly darker and arranged in a consistent order of decreasing size laterally. Ventromental plates are transparent, and moderately to well-developed. The absence of a ventromental beard is consistent with the published diagnosis (Cranston *et al.*, 1983), but this is not a reliable distinction, as I have noted for other taxa in this study. The light-coloured median mental teeth distinguish the fossils from *Heterotrissocladius*. The accessory teeth of *Heterotrissocladius*, *Rheocricotopus*, and *Zalutschia* are distinctly shorter than the median pair.

Although Sæther (1976) does not list a record from British Columbia, Washington, Oregon, or California, the genus seems to be widely distributed throughout much of North America. *Hydrobaenus* is recorded from the high arctic, south to Arkansas, Alabama, and Florida. Sæther (1976) does record one species, *H. fusistylus* (Goetghebuer) from Waterton Lakes National Park, Alberta. The larval mentum of this species is not unlike that of the British Columbia fossils. Although Sæther (1976, 1980b) has distinguished the arctic species *Oliveridia tricornis* (Oliver) with a separate genus, larval head capsules are similar to *Hydrobaenus* (Oliver and Roussel, 1983a). These 2 genera are probably not distinct (D.R. Oliver, pers. comm.). *Hydrobaenus* was collected in sediments from Black Tusk, Helm, Lost, and Mimulus Lakes.

Zalutschia Lipina (Fig. A.18d–e)

The 2 broad median teeth of *Zalutschia* fossils vary greatly in pigmentation, but are usually somewhat lighter in colour than the lateral mental teeth. Accessory teeth are present, and closely appressed to the median teeth. Bands of greater and lesser sclerotization are not conspicuous, but are associated with the median teeth of most specimens. Five additional pairs of lateral teeth, and moderately-developed ventromental

plates complete the mentum. The ventromental plates have a convex lateral margin. A distinct ventromental beard was evident on several fossil specimens. The mandible includes 1 apical tooth, and 3 inner teeth. The premandible, although seldom noted, was always bifid. In general form the head capsules resemble *Heterotrissocladius*, *Hydrobaenus*, and *Rheocricotopus*, but the distinctly bifid premandible and ventromental beard (neither were retained with the illustrated specimen) are important diagnostic characters. *Psectrocladius* fossils never have accessory teeth, do not have sclerotization banding on the median teeth, and have undivided premandibles.

Zalutschia is widely distributed throughout much of Canada, including the high arctic. In North America, *Zalutschia* is also known from South Carolina, Florida and the northern United States (Oliver, 1981a; Oliver and Roussel, 1983a; Sæther, 1976). *Zalutschia lingulata* Sæther, collected from Marion Lake (by Hamilton, 1965: reported as *Trissocladius* sp.A), is the only species reported from British Columbia (Sæther, 1976). *Zalutschia* species occur principally in lentic waters, including acid and humic lakes, and occasionally in streams (Sæther, 1976).

Nanocladius cf. *distinctus* (Malloch) (Fig. A.19a–b)

Head capsules placed with *Nanocladius* cf. *distinctus* have a mentum with a broad light coloured median region. The median tooth includes two distinct median projections. Six pairs of lateral teeth were noted, with the first two pairs being weakly pigmented. Subsequent teeth were dark and sometimes indistinct. Transparent, well–developed ventromental plates flank the mentum. Mandibles are distinctive, having a very long, weakly–pigmented apical tooth and three inner teeth.

Apart from *N.* sp. near *balticus*, *N.* cf. *distinctus* is the only member of the genus reported from British Columbia (Sæther, 1977). *Nanocladius* cf. *distinctus* is reported in lakes and streams from much of western Canada, including the Brunette River near

Vancouver (Sæther, 1977). Surface sediments from Alice Lake, and Holocene sediments from Hippa and Marion Lakes, contained remains of *Nanocladius* cf. *distinctus*.

Parametriocnemus Goetghebuer group (Fig. A.19c)

Fossils of the *Parametriocnemus* group include a pair of indistinctly separated median teeth, and five lateral pairs. The median and first lateral teeth are more lightly coloured and have several weak bands of greater sclerotization. The first lateral teeth extend almost as far forward as the median pair. The fourth lateral teeth are about as long as the third pair. The well-developed ventromental plates are complex in structure, probably including two pairs of overlapping plates. The submental setae appear to be set far forward, and are separated from each other by the combined width of the median and first lateral teeth.

The mentum appears very similar to *Parametriocnemus lundbecki* (Johannsen) (Cranston *et al.*, 1983) and to *Paraphaenocladius* Thienemann (Oliver and Roussel, 1983a: fig. 374). Cranston *et al.* (1983) note that *Parametriocnemus*, *Paraphaenocladius*, and *Psilometriocnemus* Sæther have similar-looking larvae. These genera have a composite Nearctic range including much of northern and eastern North America (Cranston *et al.*, 1983; Oliver, 1981a). Their habitats include soils and cool streams (Cranston *et al.*, 1983).

Rheocricotopus Thienemann & Harnisch (Fig. A.19d)

In my fossils, the light-coloured median teeth are flanked by a pair of much smaller, closely appressed accessory teeth. Several weak bands of greater sclerotization are apparent. The five remaining pairs of lateral teeth are darker. The broad ventromental plates have a distinctly convex lateral margin. In some cases, either the ventromental beard, or the insertions of these setae, could be discerned. The submental setae are always placed close to the ventromental plates, separated by most of the mentum.

Although both *Psectrocladius* and *Zalutschia* can have a similar-looking mentum, the submental setae are more widely separated in *Rheocricotopus.*

Rheocricotopus is widely distributed in streams across Canada, but Oliver (1981a) indicates few records in the United States. *Rheocricotopus pauciseta* Sæther was originally described from a stream near Marion Lake, B.C. (Sæther, 1969).

Eukiefferiella Thienemann/*Tvetenia* Kieffer (Fig. A.20a)

The mentum of *Eukiefferiella* and *Tvetenia* head capsules include considerable diversity of form (Bode, 1983; Cranston *et al.*, 1983). Cranston *et al.* (1983) indicate that the mentum includes 1 or 2 median teeth and 4 to 6 lateral pairs. In this study, the pronounced banding in lateral regions of the mentum, produced by alternating zones of greater and lesser sclerotization were considered to distinguish *Eukiefferiella* and *Tvetenia* larvae from other taxa. The poorly developed ventromental plates, and comparatively strong pigmentation of the head capsule were important secondary characters used for identification.

These two genera have a composite distribution, mostly in flowing waters, including much of the world. Sæther (1969) reports *Eukiefferiella hospita* Edwards from a stream near Marion Lake.

Limnophyes Eaton (Fig. A.20b–c)

The mentum of *Limnophyes* fossils includes one pair of median teeth, and five lateral pairs. The teeth are arranged in a consistent order of decreasing size laterally. Indistinct sclerotization banding can frequently be discerned near the median region. The ventromental plates are poorly developed. Although Cranston (1982b) indicates the presence of small, rounded teeth at the base of the mentum, I interpret these structures to be rounded projections of the ventromental plates. Premandibles were rarely retained

with the head capsules. The 3 teeth of the illustrated premandible resemble those portrayed by Cranston *et al.* (1983) in general form. Although *Limnophyes* cannot be reliably distinguished from *Paralimnophyes*, on the basis of these characters, *Paralimnophyes* is known from the Palaearctic only (Cranston *et al.*, 1983).

Limnophyes are widely distributed in soils, streams, and lakes (Cranston *et al.*, 1983; Oliver, 1981a), including those in arctic regions (Danks, 1981). Sæther (1969) has described two species, *L. hamiltoni* Sæther and *L. immucronatus* Sæther, as adults from Marion Lake's shoreline.

Doithrix Sæther & Sublette/*Pseudorthocladius* Goetghebuer? group (Fig. A.20d)

A number of larval Orthocladiinae head capsules were attributed to a *Doithrix/Pseudorthocladius*? group. Although the head capsules include diverse mental characteristics, only one example is illustrated. The mentum of *Doithrix/Pseudorthocladius*? group fossils included an even number of teeth, although the separation of the median pair was usually indistinct. Five lateral pairs of teeth completed the mentum. Ventromental plates were weakly to moderately-developed. The generic placement of many of the head capsules is uncertain, but most are probably attributable to the genera *Doithrix*, *Georthocladius*, *Parachaetocladius* Wülker, and *Pseudorthocladius*. Some may belong to *Bryophaenocladius* Thienemann, *Heleniella* Gowin, or *Gymnometriocnemus* Goetghebuer.

The larva of these genera occur mostly in soils and streams, although some inhabit marginal areas of lakes and ponds (Cranston *et al.*, 1983; Sæther and Sublette, 1983). These genera are poorly known, but are probably widely-distributed. *Doithrix hamiltonii* Sæther & Sublette (1983) is described from adult collections at Marion Lake.

Heterotanytarsus cf. *perennis* Sæther (Fig. A.21a–b)

A concave central region of the mentum is formed by 3 pairs of moderately pigmented teeth in *Heterotanytarsus* Spärck fossils. The 4 remaining pairs of teeth are darker and flanked by well–developed ventromental plates. The mandible bears 1 apical tooth and 3 inner teeth. Among Orthocladiinae, the strongly concave central region of the mentum is unique to *Heterotanytarsus*. Although four species of *Heterotanytarsus* have been described (Cranston *et al.*, 1983; Sæther, 1975d), only *H. perennis* is known from western North America.

Sæther (1975d) notes *Heterotanytarsus* to occur in northern, oligotrophic lakes and streams. *H. perennis* is known only from the type locality, Marion Lake (Sæther, 1975d). *Heterotanytarsus* fossils were collected from late–glacial sediments of Hippa Lake, and Holocene sediments from Marion, Mike, and Misty Lakes.

Synorthocladius Thienemann (Fig. A.21c)

Two very large, lightly pigmented median teeth are indistinctly separated, and flanked by four pairs of small teeth. These lateral teeth define a steeply–sloping lateral margin. A distinct beard was associated with the elongate ventromental plates in some fossil specimens. Several indistinct bands of greater or lesser sclerotization give the median teeth a weakly–striated appearance. The large median teeth and associated small lateral teeth produce an unusual mentum. Most fossil specimens were split along the median axis of the mentum.

Synorthocladius is associated with springs, streams, and littoral areas of lakes (Cranston *et al.*, 1983). Several species occur in North America (Cranston *et al.*, 1983), ranging from tree–line to the southern United States (Bass, 1986; Danks, 1981; Oliver, 1981a; Oliver and Roussel, 1983a).

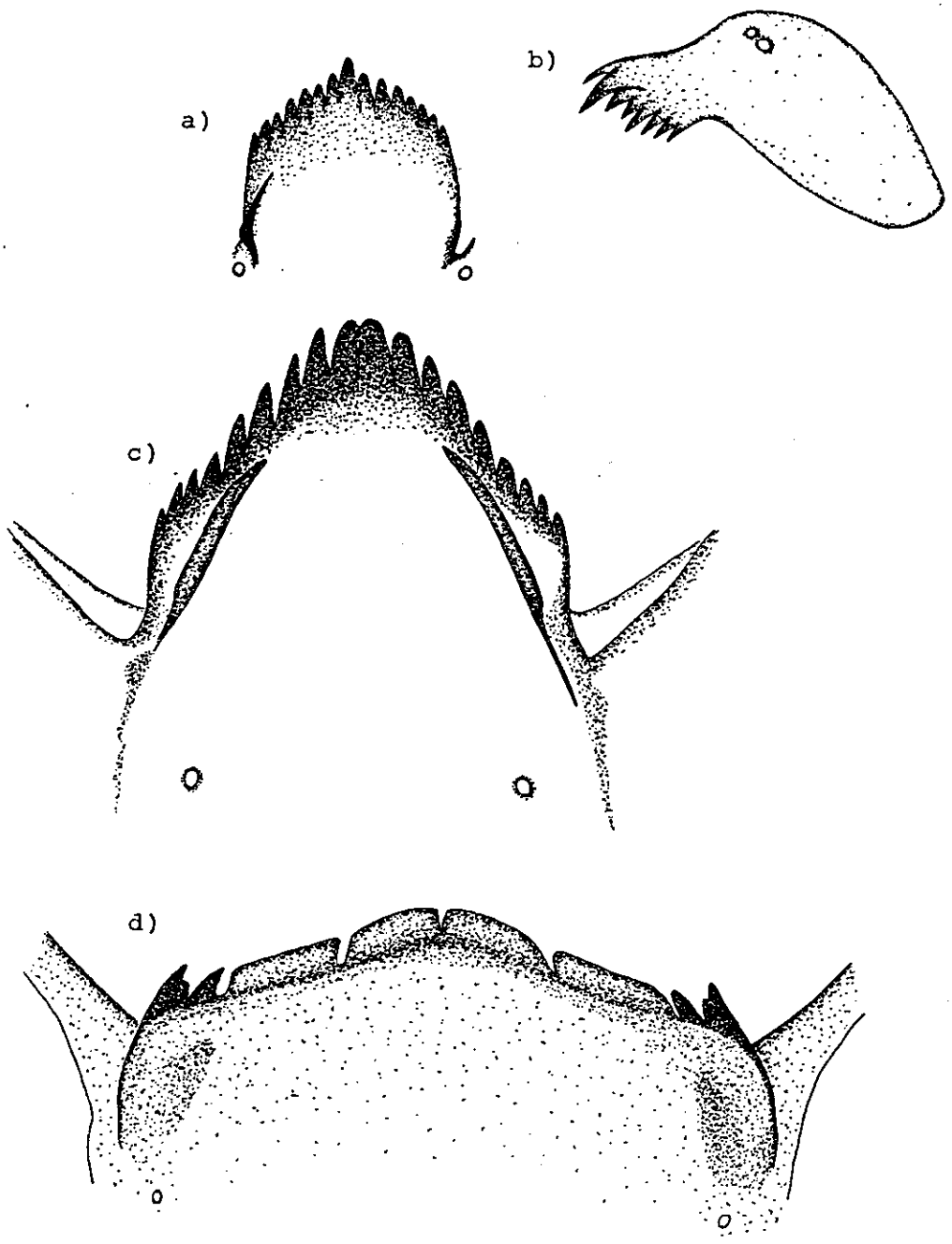

Figure A.11 Podonominae: *Boreochlus* Edwards (690X): a) mentum, b) mandible – Diamesinae: *Diamesa* Meigen? (1400X): c) mentum – *Protanypus* Kieffer (630X): d) mentum

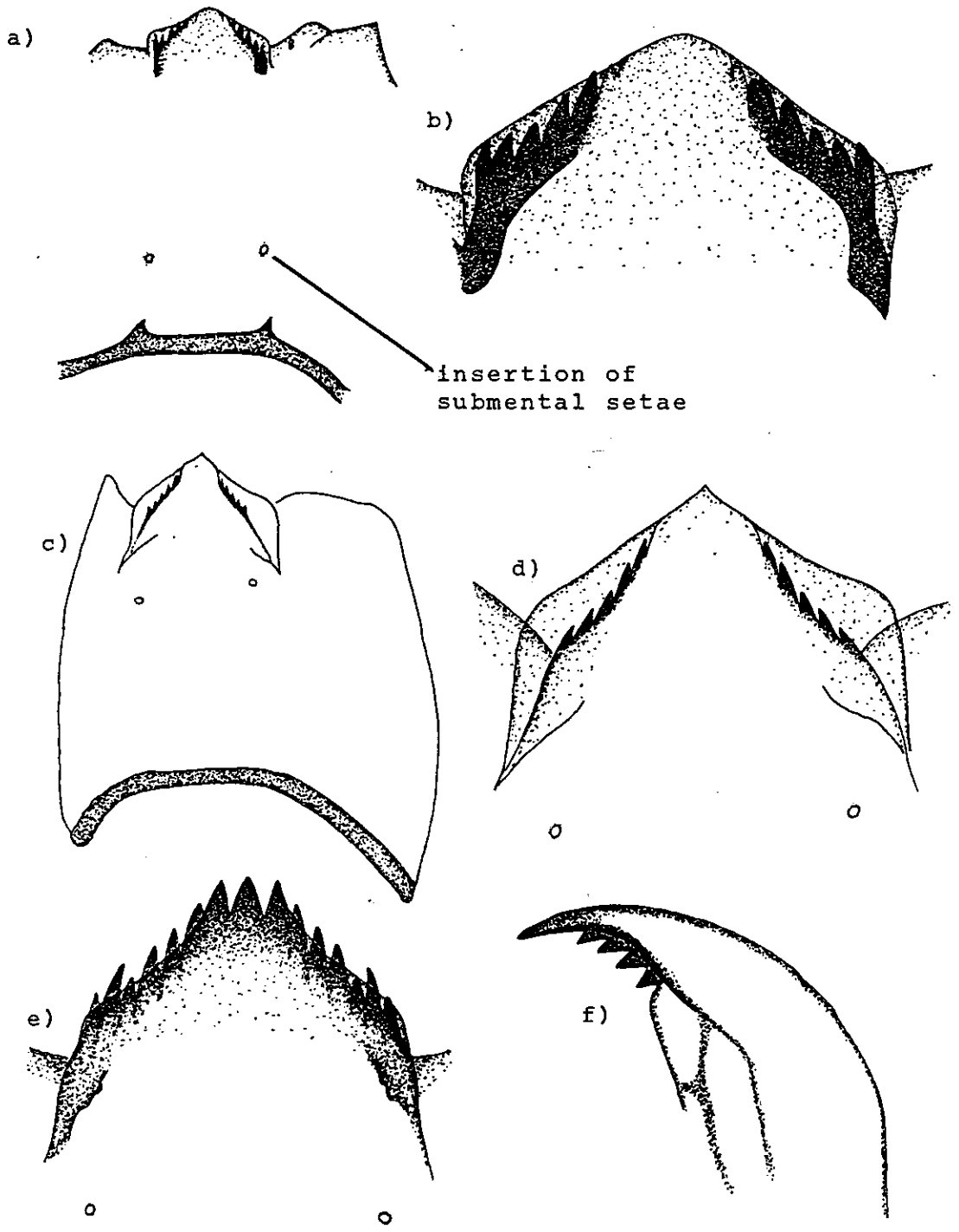

Figure A.12 *Pagastia* Oliver: a) head capsule (270X), b) mentum (1100X)– *Potthastia* Kieffer?: c) head capsule (410X), d) mentum (970X) – *Pseudodiamesa* Goetghebuer (800X): e) mentum, f) mandible

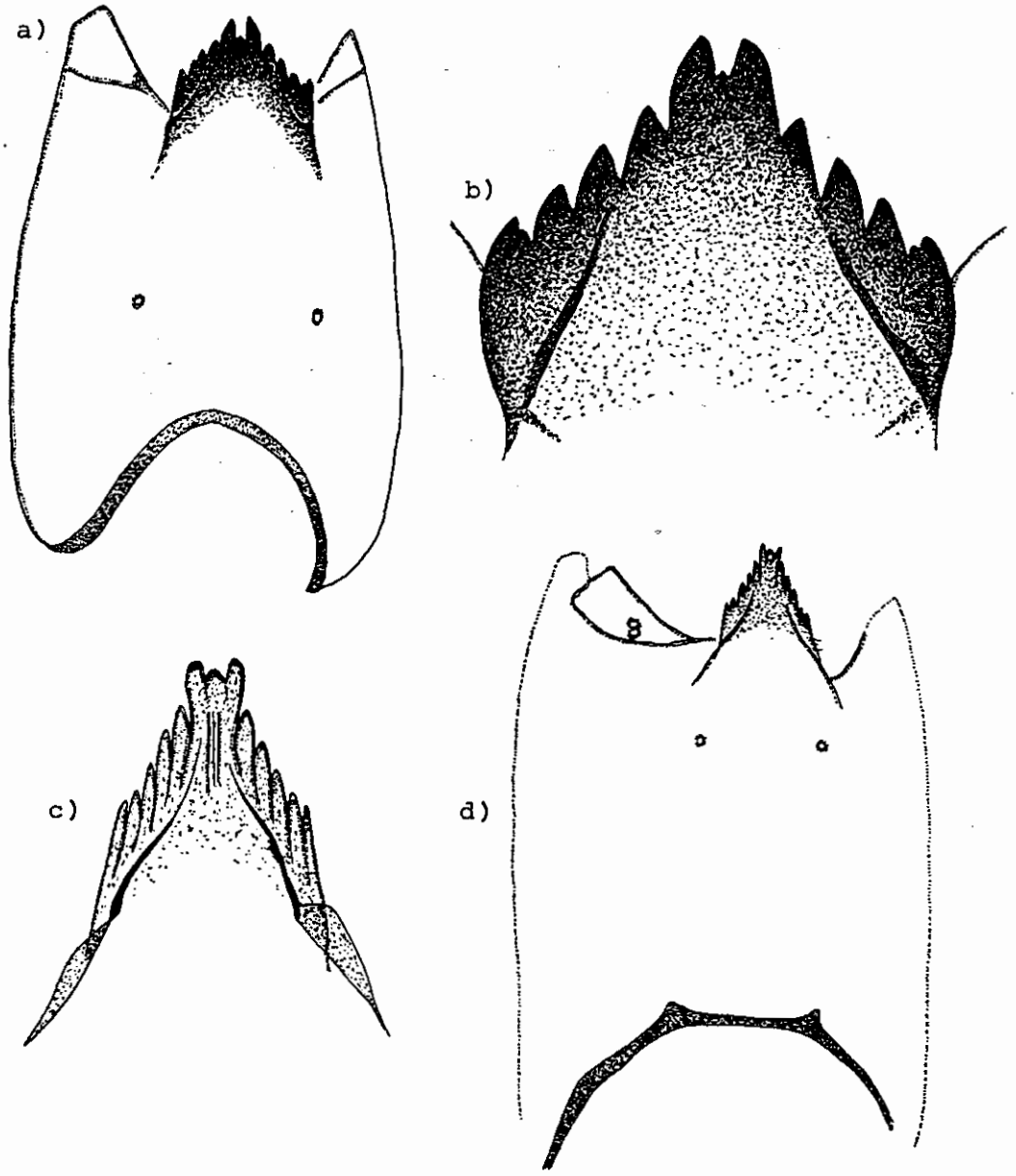

Figure A.13 Orthocladiinae: *Brillia* Kieffer/*Euryhapsis* Oliver: a) head capsule (370X), b) mentum (1100X) - *Corynoneura* Winnertz/*Thienemanniella* Kieffer: c) mentum (590X), d) head capsule (1400X)

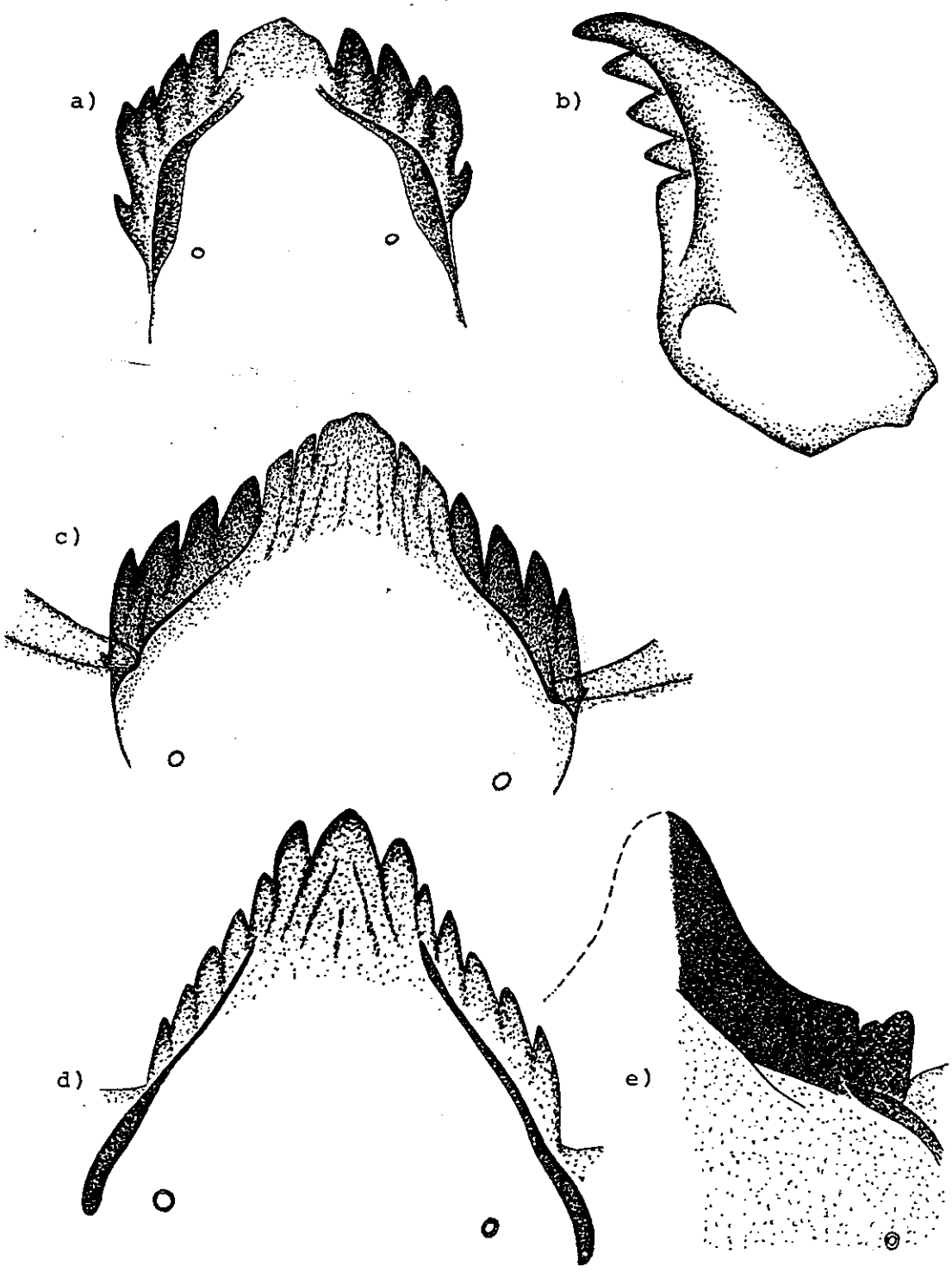

Figure A.14 *Smittia* Holmgren/*Pseudosmittia* Goetghebuer? group (1800X): a) mentum, b) mandible - *Cricotopus* v.d.Wulp/*Orthocladius* v.d.Wulp/*Paratrichocladius* Santos Abreu: c) mentum (990X), d) mentum (820X) - *Orthocladius (Symposiocladius) lignicola* Kieffer (1600X): e) mentum

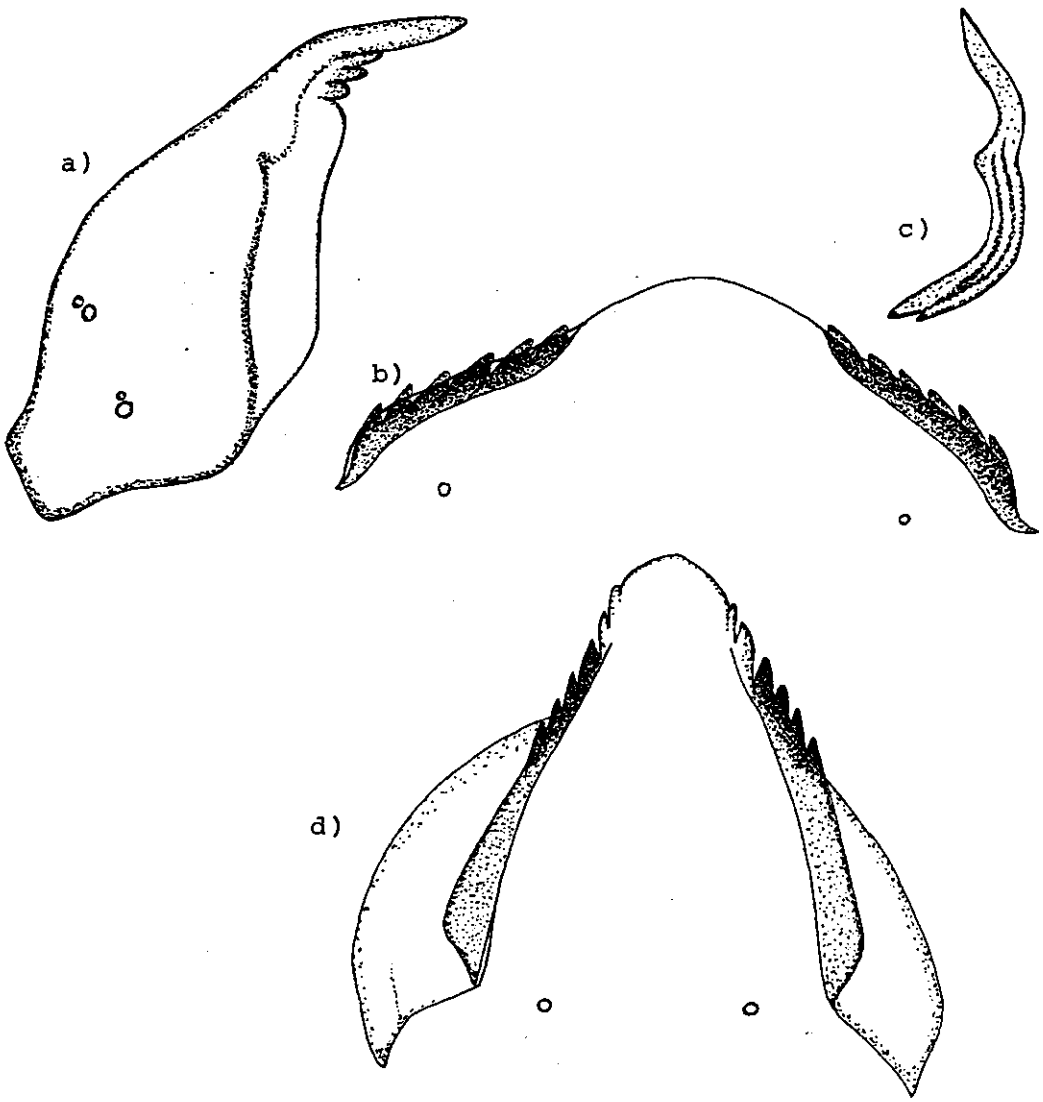

Figure A.15 *Paracladius* Hirvenoja (840X): a) mandible, b) mentum, c) premandible – *Stilocladius* Rossaro (1200X): d) mentum

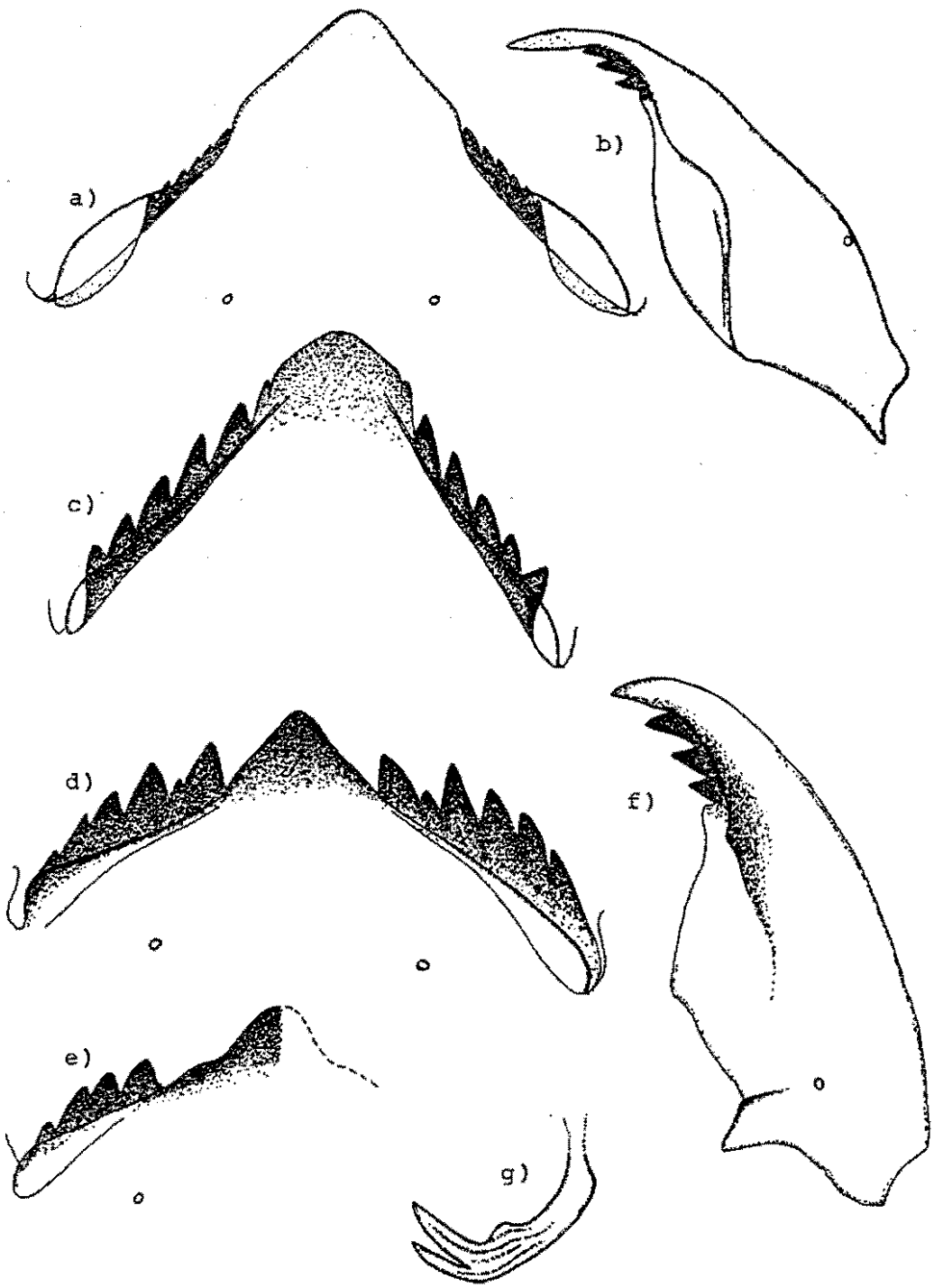

Figure A.16 *Parakiefferiella*? cf. *triquetra* (Chernovskii) (830X): a) mentum, b) mandible, – *Parakiefferiella* cf. *bathophila* (Kieffer) (1400X): c) mentum – *Parakiefferiella* sp.A: d) normal mentum (1200X), e) worn mentum (970X), f) mandible (1200X), g) premandible (1200X)

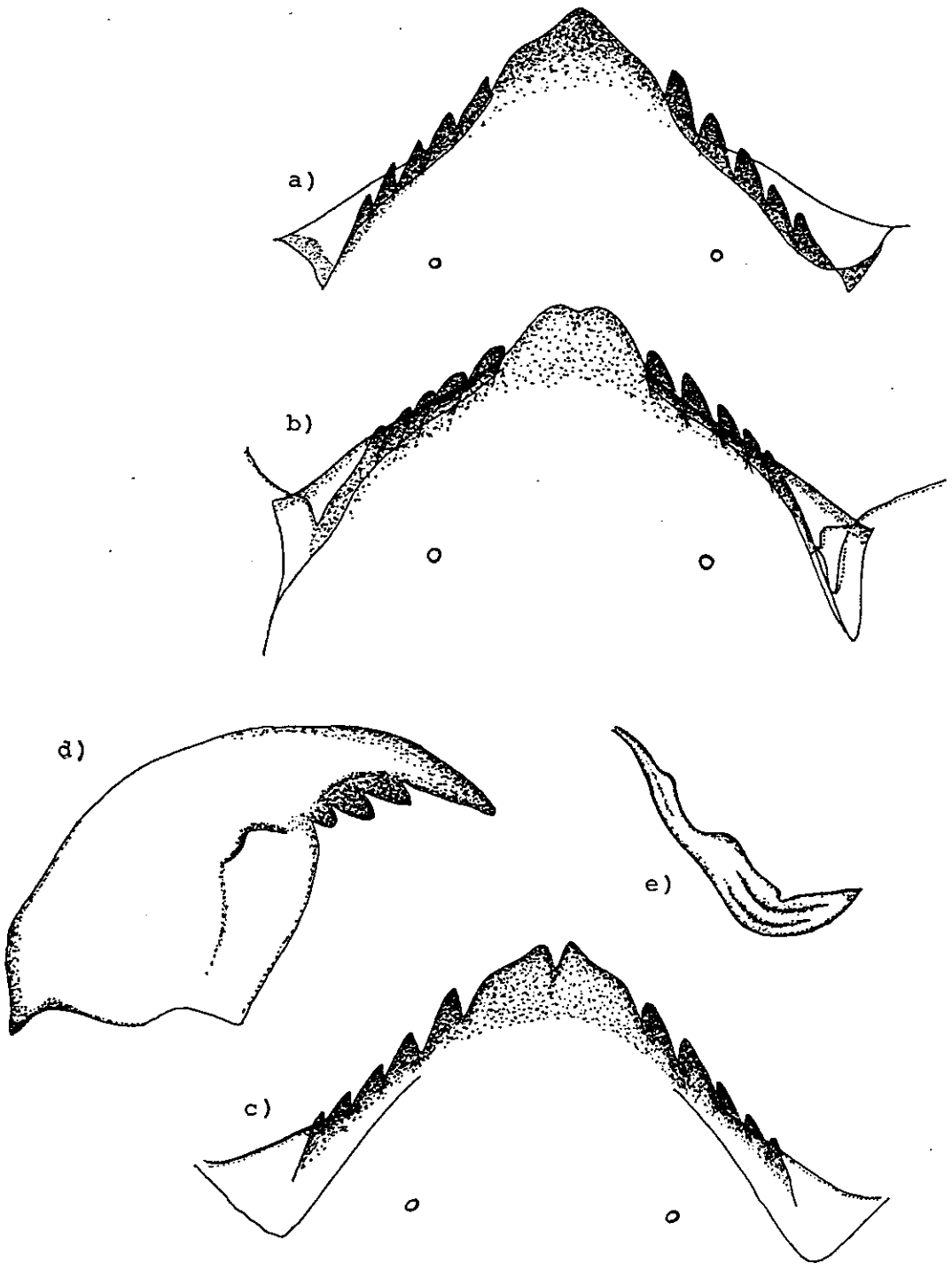

Figure A.17 *Psectrocladius* subg. *Monopsectrocladius* Laville (1400X): a) mentum - other *Psectrocladius* Kieffer: b) mentum (1800X), c) mentum (1540X), d) mandible (1540X), e) premandible (1540X)

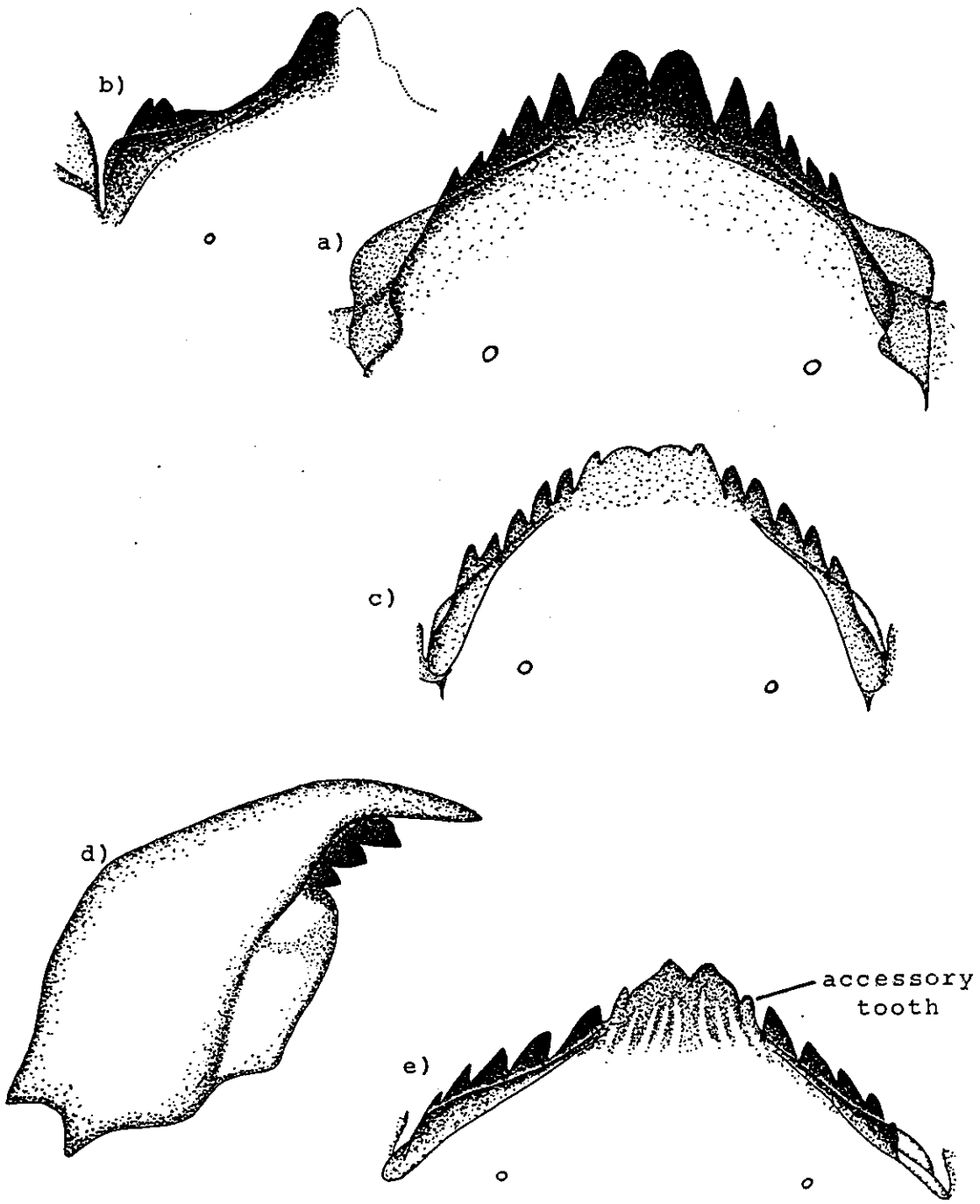

Figure A.18 *Heterotrissocladius* Spärck: a) normal mentum (1300X), b) worn mentum (540X) - *Hydrobaenus* Fries (1700X): c) mentum - *Zalutschia* Lipina (640X): d) mandible, e) mentum

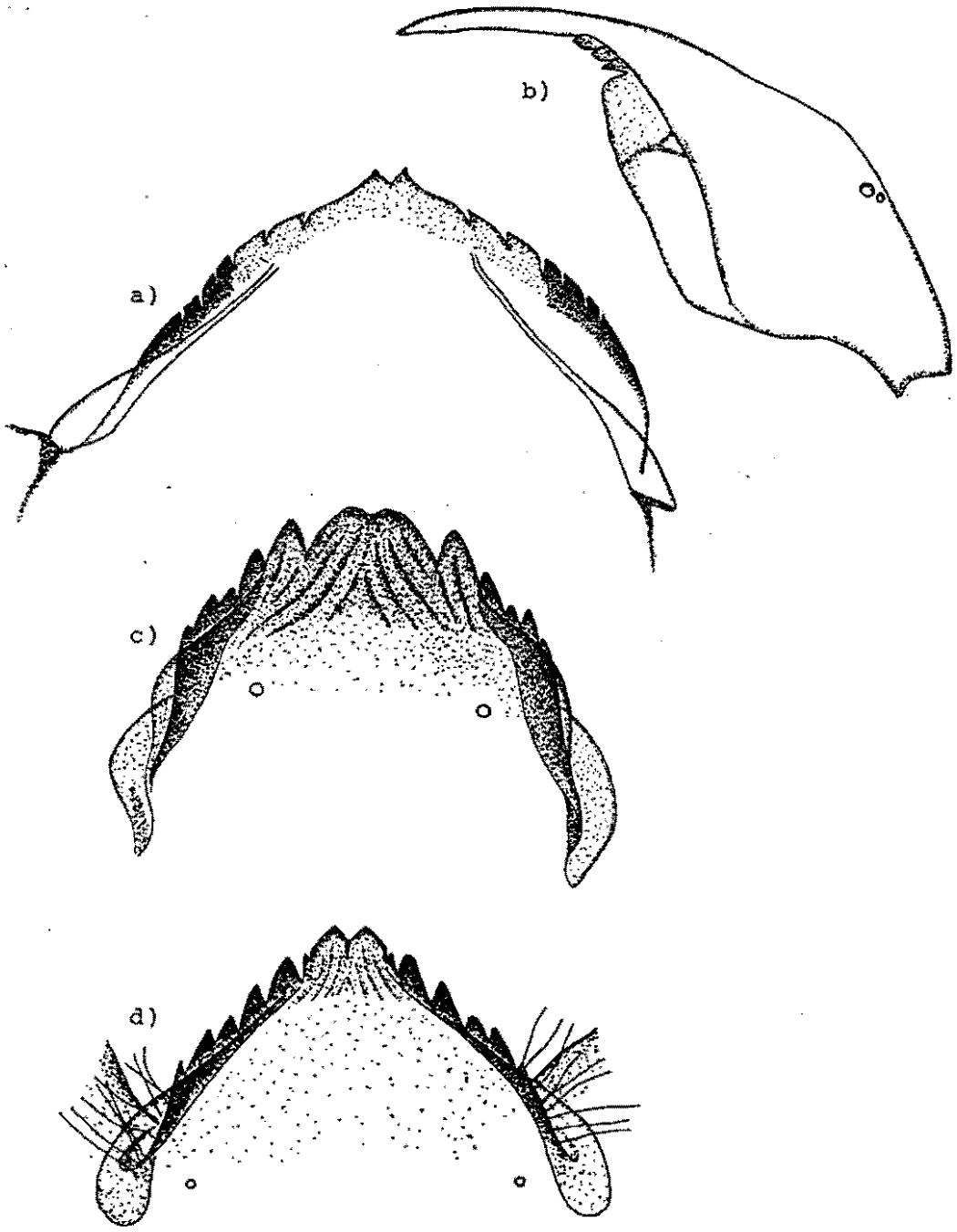

Figure A.19 *Nanocladius* cf. *distinctus* (Malloch) (1400X): a) mentum, b) mandible - *Parametriocnemus* Goetghebuer group (980X): c) mentum - *Rheocricotopus* Thienemann & Harnisch (740X): d) mentum

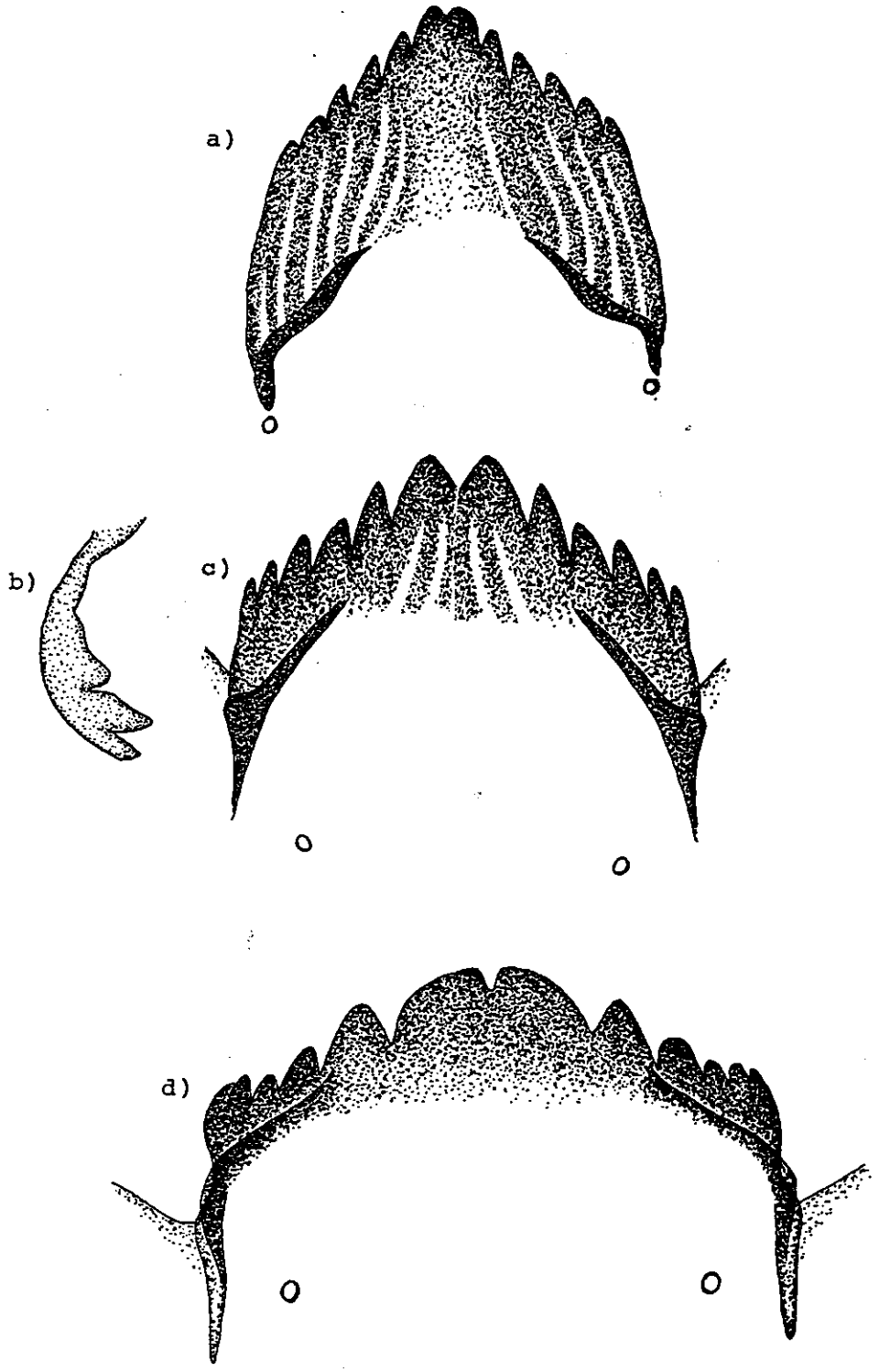

Figure A.20 *Eukiefferiella* Thienemann/*Tvetenia* Kieffer (2100X): a) mentum - *Limnophyes* Eaton (1300X): b) premandible, c) mentum - *Doithrix* Sæther & Sublette/*Pseudorthocladius* Goetghebuer? group (1400X): d) mentum

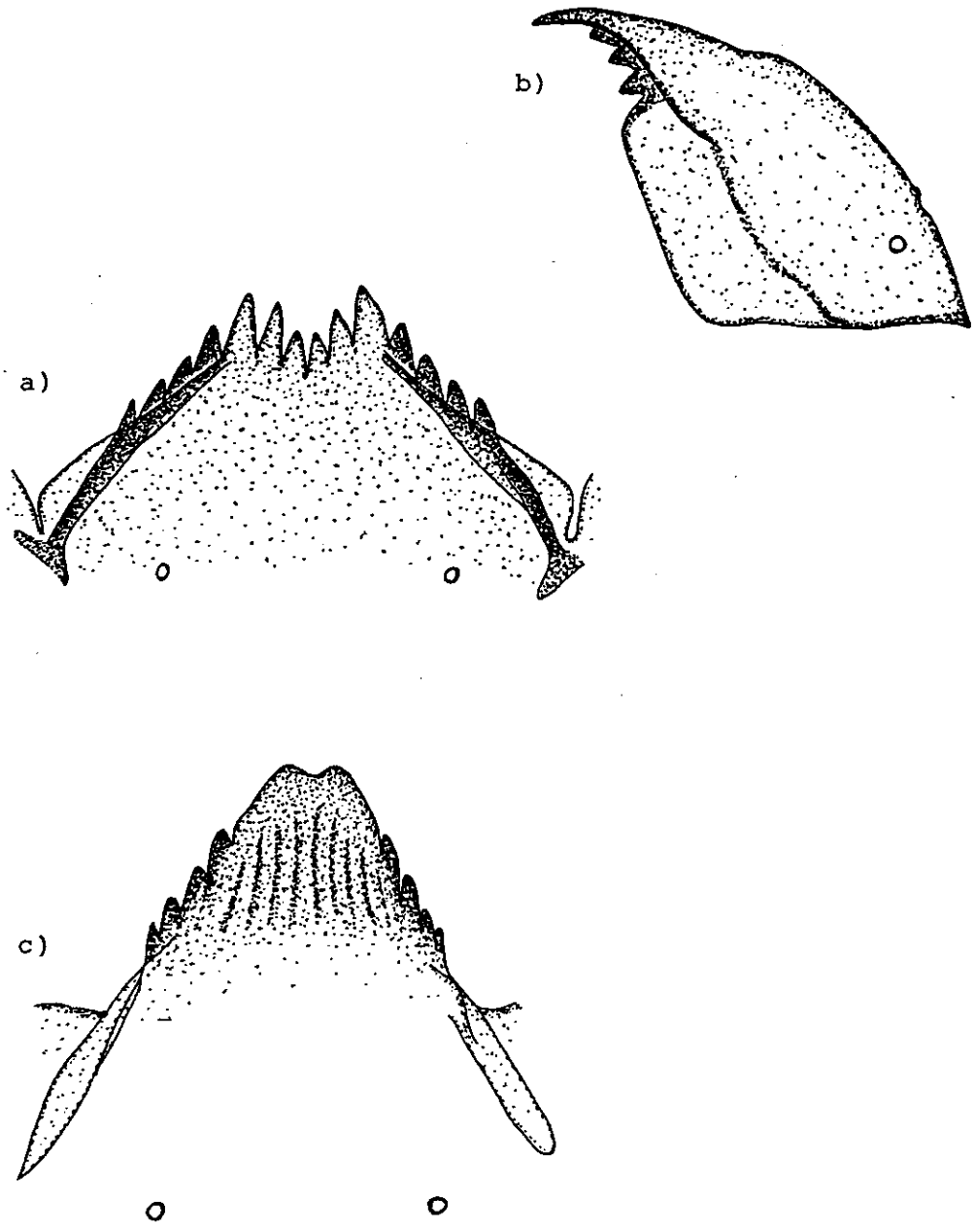

Figure A.21 *Heterotanytarsus* cf. *perennis* Sæther (1400X): a) mentum, b) mandible – *Synorthocladius* Thienemann (940X): c) mentum