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**[SHORT COMMUNICATION]**

# Formation of the Entognathy in *Baculentulus densus* (Imadaté) (Hexapoda: Protura, Acerentomidae)

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Hennig's "Entognatha-Ectognatha System" (1969) has been widely accepted with little challenge; however, recent comparative paleontological (Kukalová-Peck, 1987) and morphological (Koch, 1997) researches have cast some doubt on the accuracy of Entognatha, especially in terms of the homology of the entognathy among three entognathan orders, on which great importance has been placed as their most reliable synapomorphy. Ikeda and Machida (1998) compared entognathy formation in Diplura with that in Collembola (Uemiya and Ando, 1987), and suggested that Diplura greatly differ from Collembola in the manner of entognathy formation, and that, at least concerning Collembola and Diplura, the homology of entognathy is not always substantiated (cf. Machida, 2006). The elucidation of entognathy in Protura is therefore becoming more significant. This report is a preliminary note on entognathy formation in a proturan, *Baculentulus densus* (Imadaté).

Formation of the entognathy starts in the initial stage of blastokinesis in *Baculentulus densus*. The terga of the mandibular, maxillary and labial segments develop and unite, forming a belt-shaped mouth fold anlage (Figs. 1, 2A). The lacinia, galea and palp are differentiated in the maxillary anlage (Fig. 2A), and the coxopodite and palp in the labial anlage (Fig. 2B). After completion of blastokinesis, mouth folds on both sides develop and extend posteriorly along the lateral margins of head lobes, finally forming the posterior region of the definitive head capsule, and anteriorly they continue to the labral anlage without demarcation (Fig. 3A, B).

The embryo further develops, and the labial coxopodites on both sides start to spread and move medially. Mouth folds extend ventrally to cover the gnathal parts (Fig. 4). Figure 5 shows a completed entognathy in a prelarva, in which labia on both sides meet and the mandible and maxilla are covered, frontally with labrum, laterally with mouth folds, and posteriorly with labium.

We described the outline of embryonic development in *Baculentulus densus*, reporting that the mouth fold is derived from three gnathal terga (Fukui and Machida, 2006). Although our previous statement can be accepted without amendment, our present study, in which we succeeded in dissecting embryos out of the egg shell, reveals that we (Fukui and Machida, 2006) misleadingly identified the mandible as the mandibular tergum, the galea as the maxillary tergum and the maxillary palp as the labial tergum, due to a lack of resolution in the observation made through the chorion with numerous protuberances on its surface [compare Fig. 2A herein with Fig. 9 of Fukui and Machida (2006)].

The entognathy in Diplura is formed with ventral extension of the mouth fold derived from the mandibular and maxillary terga, involving the rotation of labial appendages and partition of the maxillary tergal element to form the admentum (Ikeda and Machida, 1998), and that in Collembola is formed with simple ventral extension of the mouth folds derived from the three gnathal terga (Uemiya and Ando, 1987). Although details on the formation of the proturan entognathy remain sketchy and further examination is required, the entognathy formation of Protura could be characterized by: 1) formation of the mouth fold by the terga of three gnathal segments which are united with each other in earlier stages, 2) unification of the mouth fold with the labrum. The entognathy of any of these orders in Entognatha may be formed with an independent plan for each.

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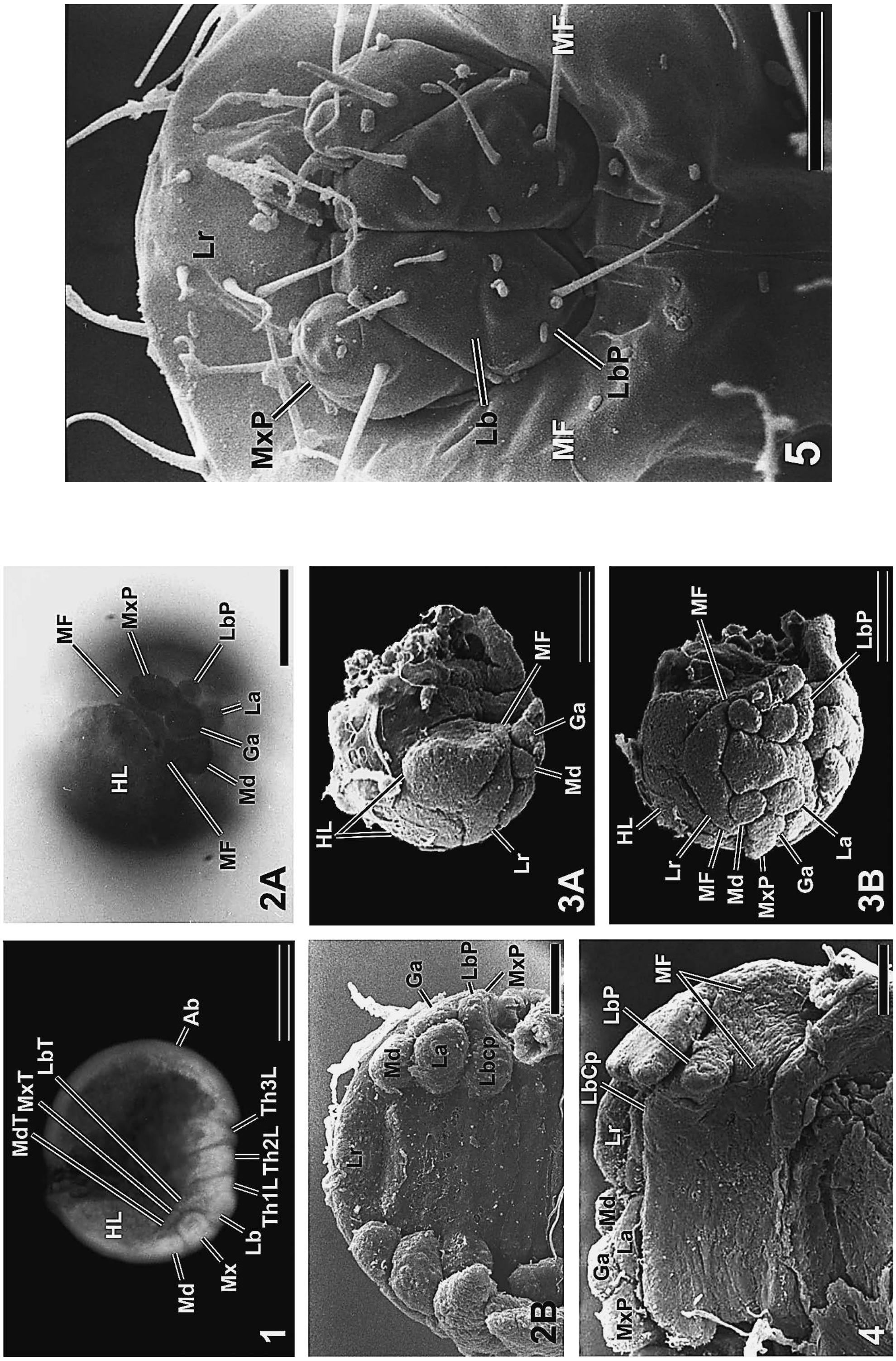
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Figures 1–5

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Figs. 1–5 Successive stages of entognathy formation of a proturan *Baculentulus densus*.

Fig. 1 An embryo in the initial stage of blastokinesis. The terga of the mandibular, maxillary and labial segments differentiated, lateral view, DAPI staining, UV excitation.

Fig. 2 Cephalic regions of an embryo in the later stage of blastokinesis. Gnathal appendages develop and start to assume their characteristics; although the mandible remains a simple swelling, the palp and coxopodal endites differentiate in the maxilla and the palp and coxopodal region in the labium. A. The gnathal terga develop and unite to form a belt-shaped mouth fold anlage, lateral view, hematoxylin staining. B. The mandibular, maxillary and labial appendages on each side are arranged in a row, and the labial appendages on each side have yet to move medially, ventral view, SEM.

Fig. 3 An embryo in the initial stage of dorsal closure. Mouth folds on both sides develop and extend posteriorly, and anteriorly continue to the labral anlage without demarcation. The left side of the thorax of this embryo is severely distorted. SEM. A. Dorsolateral view. B. Frontoventral view.

Fig. 4 Cephalic region of an embryo in the later stage of dorsal closure. Labial coxopodites on both sides start to spread and move medially. Mouth folds extend ventrally to cover the gnathal parts, ventrolateral view, SEM.

Fig. 5 Completed entognathy of a prelarva. Mandible and maxilla are covered frontally with labrum, laterally with mouth folds and posteriorly with labia on both sides moved medially to meet, ventral view, SEM.

Ab: abdomen, Ga: galea, HL: head lobe, La: lacinia, Lb: labium, Lbcp: labial coxopodite, LbP: labial pulp, LbT: labial tergum, Lr: labrum, Md: mandible, MdT: mandibular tergum, MF: mouth fold, Mx: maxilla, MxP: maxillary pulp, MxT: maxillary tergum, Th1–3L: first to third thoracic appendages. Scales = 1, 2A, 3A, B: 50 $\mu$m; 2B, 4, 5: 10 $\mu$m.