Jpn. J. Ent., **57** (3): 517–526. September 25, 1989

Comparative Morphology of the Staphylinidae and the Allied Groups (Coleoptera, Staphylinoidea)

IX. General Structure, Lateral Plates, Stigmata and 1st to 7th Segments of Abdomen[1)]

Shun-Ichiro NAOMI[2)]

Entomological Laboratory, Faculty of Agriculture,
Kyushu University, Fukuoka, 812 Japan

Abstract A comparative morphology of the general structure, lateral plates, stigmata and 1st to 7th segments of the abdomen of the Staphylinidae and the allied groups is dealt with. The abdomen is composed of 10 segments and is movable dorsoventrally in general, but it is almost immovable in the Micropeplinae and the pselaphid group. The lateral plates are one- or two-paired in each of the first 7 segments, but are sometimes lost in some groups. The stigmata are paired in each of the first 8 segments in general. They tend to atrophy from the median 4th to 6th segments, but not from the last 8th. The terga and sterna are generally concealed under elytra and hind coxae, respectively, and are weakly pigmented and sclerotized in the 1st and 2nd segments of the abdomen. The hologastrous, haplogastrous as well as cryptogastrous types are found for the structure of the 2nd sternum. The sterna are more convex and a little broader than the terga in the 3rd to 7th segments in general.

Comparative Morphology of Abdomen

The general structure, lateral plates, stigmata and 1st to 10th segments of abdomen, abdominal glands, male genitalia, and female spermatheca are dealt with. In this section, the dorsal plate is regarded as the tergum, the ventral one as the sternum. The sclerite between the tergum and the sternum is called "lateral plate" which is equivalent to the paratergite in the descriptive study. It is not identical with the pleuron in the morpholgical sense. The "tergosternal suture" applies to the suture when it directly demarcates the tergum from the sternum and the lateral plates are absent.

In this paper, the general structure, lateral plates, stigmata and 1st to 7th segments of the abdomen are discussed.

---

1) Contribution from the Entomological Laboratory, Faculty of Agriculture, Kyushu University, Fukuoka (Ser. 3, No. 266).

2) Present address: Natural History Museum and Institute, Chiba, 955-2 Aoba-chô, Chiba, 280 Japan.

1. *General Structure*

The abdomen is fundamentally composed of 10 segments in the Staphylinoidea. The dorsum of the abdomen is almost covered by elytra so that it is weakly sclerotized and/or pigmented in the Catopiaria, Silphidae and Scydmaenidae. On the other hand, the elytra are usually short and truncate, and the last 3, 4, 5, 6 or 7 abdominal terga are exposed and strongly sclerotized in the Oxytelidae, Staphylinidae, Oxyporidae and Scaphidiidae. The 1st and 2nd sterna are reduced or completely lost. If present, they are usually concealed under hind coxae. The 3rd to 8th sterna are exposed and strongly sclerotized. The 9th and 10th segments are almost telescoped into the 8th in general. The abdomen is usually movable dorsoventrally, but the visible abdominal segments are almost immovable and partially or completely connate to one another in the Micropeplinae (Fig. 1 F) and pselaphids (Fig. 1 D, G).

2. *Position and arrangement of lateral plates and stigmata*

The lateral plates are one- or two-paired in each of the first 7 segments and are dorsolateral or dorsal in position, while the stigmata are present in a pair in each of the first 8 segments and are dorsal in position in the Staphylinoidea (Figs. 1 A–I, 2 A–I). When considering evolution of the structures at generic and tribal levels, however, they show such tendencies as increase of the number of the lateral plates, atrophy of the stigmata, etc. These characters are, therefore, of importance for generic and tribal classification of the Staphylinoidea, although few workers had hitherto paid attention to them.

In the following paragraphs, the position and arrangement of the lateral plates and stigmata are mentioned for each of the representatives of the Staphylinoidea. The lateral plate and stigma are abbreviated "lp" and "st", respectively. In the formula of the lateral plates, "0" means the complete disappearance of the lateral plates in the abdomen, and "1" means the presence of a pair of the lateral plates on each of the first 7 segments. Figures from the front backward mean number of the lateral plates on one side of the 1st to 7th abdominal segments. For example, the lateral plate is absent in the 1st segment, one in the 2nd and they are two in each of the 3rd to 7th in the formula of "0–1–2–2–2–2–2".

In the descriptions of the stigmata, figure means abdominal segment. The stigmata are situated on the terga in the abdominal segments indicated by the figures without parentheses, while they are situated on the membranous areas between the terga and the lateral plates in the abdominal segments indicated by the figures in parentheses. "(0)" means that no stigma is found in a series of the abdominal segments just before the mark. For example, "4–6(0)" means that no stigma is found in the 4th to 6th abdominal segments.

Ptiliidae. *Acrotrichis*, lp: 1, st: (1), 2–8.

Leiodidae. *Eucyrta*, lp: 1, st: (1–4), 5–8.

Catopidae. *Catops*, lp: 1, st: 1–2, (3–6), 7–8.

Agyrtidae. *Pteroloma*, lp: 0, st: (1–7), 8. *Apteroloma*, lp: 0, st: 1, (2–6), 7–8. *Pelatines*, lp: 1, st: 1, (2–7), 8.

Silphidae. *Nicrophorus*, lp: 1, st: (1–4), 5–8. *Xylodrepa*, lp: 1, st: 1, (2–5), 6–8.

The lateral plates are usually paired in each segment in the Catopiaria and Silphidae except in *Pteroloma* and *Apteroloma*. The stigmata in the Catopiaria and Silphidae are situated on the membranous areas of more basal segments than in the Staphylinida.

Oxytelidae. *Micropeplus*, lp: 1, st: 1–3, 4–6 (invisible), 7–8. *Piestoneus*, lp: 1–1–2–1–1–1–1, st: 1–8. *Apatetica*, lp: 1–1–2–2–1–1–0, st: (1), 2–8. *Lispinus*, lp: 0, st: 1–8. *Eleusis*, lp: 0, st: 1–8. *Priochirus*, lp: 0, st: 1–2, 3–7(0), 8. *Osorius*, lp: 0, st: 1–8 or 1, 2–7(0), 8. *Megarthrus*, lp: 1, st: 1–8. *Proteinus*, lp: 1, st: 1–3, 4–6(0), 7–8. *Camioleum*, lp: 1, st: (1–2), 3–8. *Trigonodemus*, lp: 0–0–0–1–1–1–0, st: (1–2), 3–8. *Brathinus*, lp: 1, st: (1–4), 5–8. *Philydrodes*, lp: 1, st: (1–2), 3–8. *Olophrum*, lp: 1–1–1–1–1–1–2, st: 1–8. Most genera of the Oxytelinae, lp: 0 (or 1)–0 (or 1)–2–2–2–2–2, st: (1), 2–8 and 1–8 (common). *Deleaster*, lp: 1, st: (1–2), 3–8. *Pseudopsis*, lp: 1–1–1–1–1–1–2, st: (1–2), 3–8.

The lateral plates are usually in a pair in each segment in the Oxytelidae, but they are absent in the Eleusini, Thoracophorini, Leptochirini, Lispinini and Osorinae, and the tergosternal sutures of the 3rd to 7th segments also have completely disappeared in the latter four taxa. The lateral plates are usually two-paired in each of the 3rd to 7th segments in the Oxytelinae except in *Deleaster*. The stigmata of the 3rd to 8th segments are usually incorporated on the terga in the Oxytelidae. The stigmata atrophy in various degrees in the *Micropeplus* (Fig. 1 F), *Priochirus*, *Osorius* and *Proteinus*.

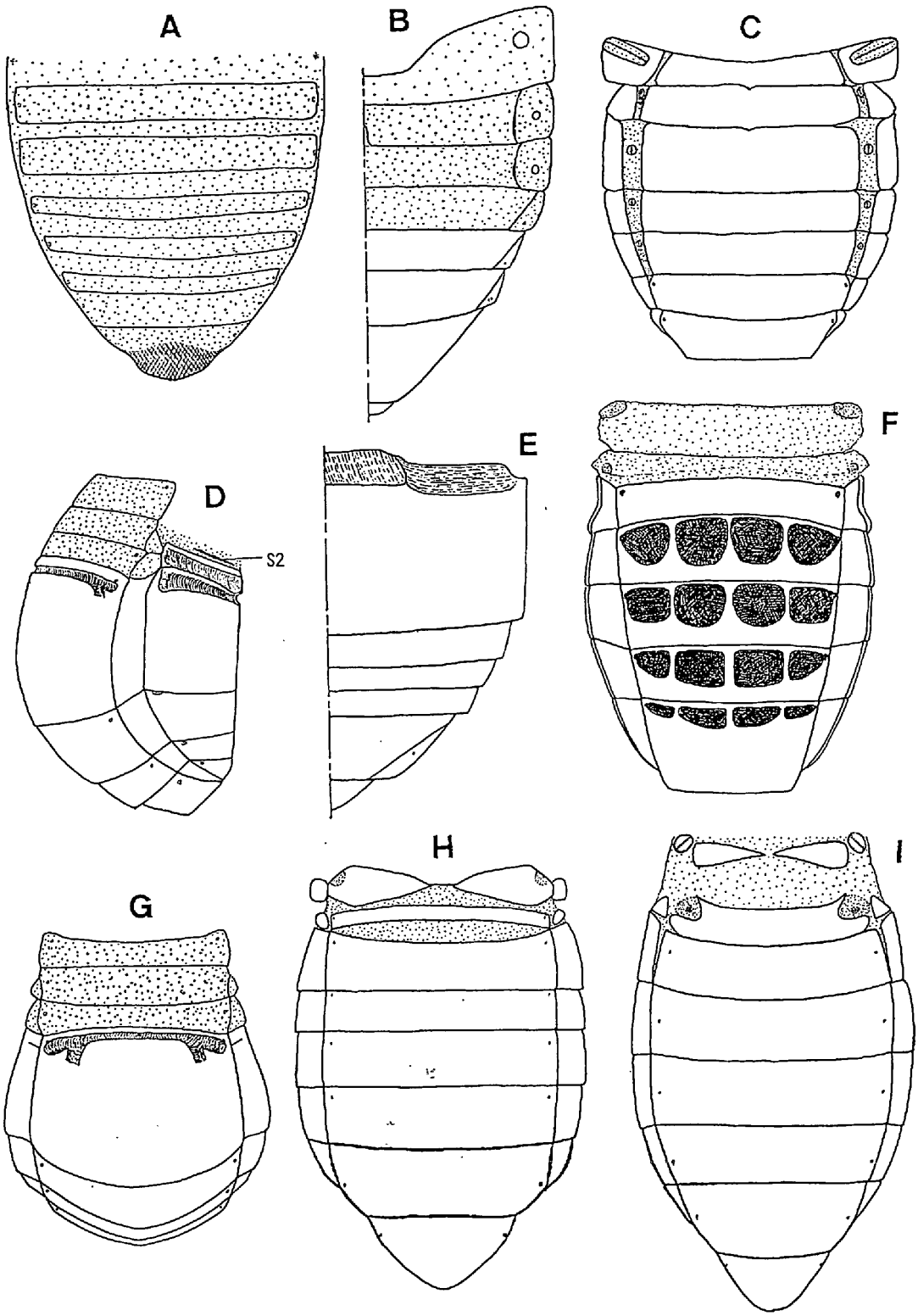
Staphylinidae. Most genera of the Tachyporinae, lp: 0 (or 1)–0 (or 1)–2–2–2–2–2, st: 1–3, 4–6(0), 7–8. *Tachinus*, lp: 0–1–2–1–1–1–1, st: 1–3, 4–6(0), 7–8. *Sepedophilus*, lp: 0–1–1–0–0–0–0, st: 1–3, 4–6(0), 7–8. *Derops*, lp: 0–1–2–1–1–1–0, st: 1–8; Aleocharinae, Staphylininae, Xantholininae and Paederinae, lp: 0(or 1)–0 (or 1)–2–2–2–2–2, st: 1–8. *Palaminus* lp: 0, st: 1–8.

The lateral plates are two-paired in each of the 3rd to 7th segments in the majority of the Staphylinidae. The stigmata are usually incorporated on the terga. The stigmata of the 2nd segment are found on the lateral plates in *Megalopaederus*, *Domene* and *Lobrathium*. The 4th to 6th stigmata usually atrophy in the Tachyporinae (Fig. 2 A). The tergosternal sutures are lost in the 4th to 6th segments in *Sepedophilus* and in the 3rd to 7th ones in *Palaminus*.

Scaphidiidae. *Scaphisoma*, lp: 0–0–0–1–1–1–0, st: (1–3), 4–8(0). *Scaphidium*, lp: 1, st: anomalous.

The stigmata are anomalous in position in *Scaphidium*. The 1st stigma is placed on the tergum and the 2nd to 7th ones are on the lateral plates (Fig. 1 B). The 1st to 6th stigmata are situated dorsally, but the 7th is ventrally (Fig. 1 E).

Scydmaenidae. *Euconnus*, lp: 0, st: 1–8.



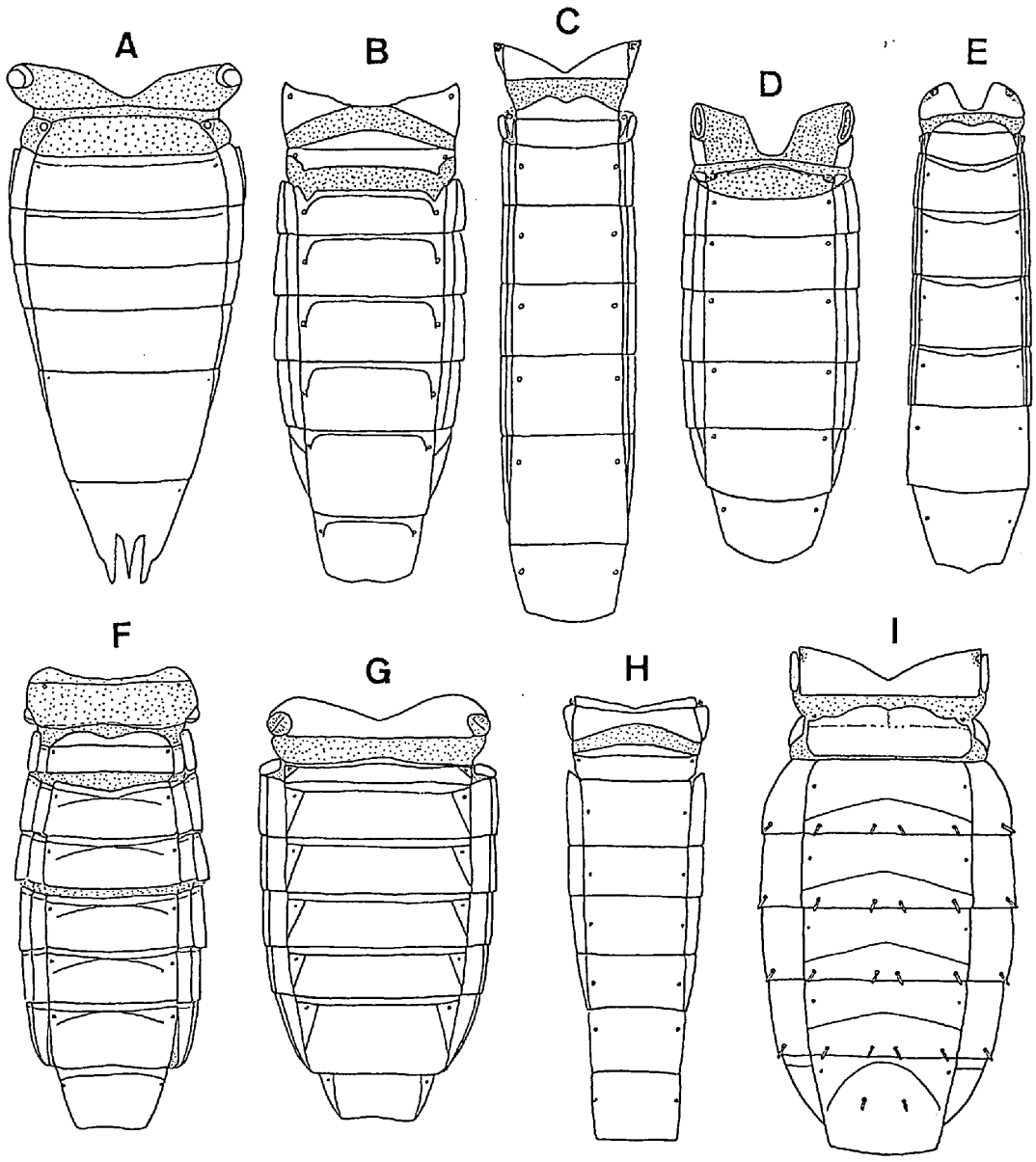


Fig. 1 (on p. 520). A, *Euconnus fustiger*; B, E, *Scaphidium japonum*; C, *Xylodrepa sexcarinata*; D, G, *Lasinus monticola*; F, *Micropeplus fulvus*; H, *Megarthrus japonicus*; I, *Philydrodes aquatilis*. A–C, F–I, Abdomen in dorsal view; D, same in lateral view; E, same in ventral view.

Fig. 2 (on p. 521). A, *Tachinus japonicus*; B, *Aleochara curtula*; C, *Nudobius apicipennis*; D, *Platydracus paganus*; E, *Paederus parallelus*; F, *Oxytelus nigriceps*; G, *Oxyporus japonicus*; H, *Stenus alienus*; I, *Pseudopsis watanabei*. A–I, Abdomen in dorsal view.

Oxyporidae. *Oxyporus* and *Megalopinus*, lp: 0–1–2–2–2–2–2, st: 1–8. *Stenus*, lp: 1–0–1–1–1–1–0, st: (1), 2–8. *Hypostenus*, lp: 0, st: 1–8. *Dianous*, lp: 0–0–1–1–1–1–0, st: 1–8. *Edaphus*, lp: 0–0–1–1–1–1–1, st: 1–8. *Stenaesthetus*, lp:

0, st: 1–8. *Lasinus*, lp: 1, st: 1–8. *Philoscotus*, lp: 0, st: 1–6(0), 7–8. *Petaloscapus*, lp: 0, st: 1–4 (0), 5–6, 7–8(0). *Bryaxis* lp: 1, st: 1–2(0), 3–8. *Diartiger* lp: 0–0–1–1–1–1–0, st: 1–3, 4–6(0), 7–8.

The lateral plates are two-paired in each of 3rd to 7th segments in the Oxyporinae and Megalopininae, while they are in a pair in each segment or completely lost in the other Oxyporidae. The stigmata are usually incorporated on the terga in the Oxyporidae and the atrophy is found in some pselaphids. The tergosternal sutures are lost in the 3rd to 6th segments in *Hypostenus*, *Tesnus* and *Petaloscapus* and in the 4th to 6th segments in *Stenaesthetus* and *Philoscotus*.

The one-paired condition is considered the GPC for the lateral plate and it has been evolved into two advanced conditions. The lateral plate is longitudinally divided into 2 plates in one side of each segment, and consequently the staphylinids have acquired higher movability of the abdomen. On the other hand, the lateral plates are fused with the terga and sterna, or lost so that the abdomen becomes more immovable. The former condition is very often found in the predaceous species, while the latter is in the species which live in rotten trees or under barks.

The stigmata are situated on the membranous areas in the GPC. This is generally correlated with long elytra as in the Silphidae. The stigmata have been shifted on the rigid terga or the membranous areas have been sclerotized around the stigmata in accordance with shortening of the elytra. They atrophy in the final stage of the evolution. Interestingly, they tend to atrophy from the median 4th to 6th segments, but not from the last 8th. The atrophy has independently occurred in the Tachyporinae, some Oxytelidae and some pselaphids.

3. *First abdominal segment*

Tergum. The 1st tergum is more closely connected with the metanotum than with the 2nd tergum. It is a transverse and subquadrangular plate (GPC), and a broad and/or deep emargination is present at the middle of the anterior margin (Fig. 2 A, C–E, G, I) or not (Fig. 1 C, F–G). The 1st tergum sometimes consists of a pair of triangular plates and they are completely separated from each other in various lineages (Figs. 1 H–I, 2 B). It is usually submembranous and weakly pigmented (GPC), or is moderately pigmented in such genera as *Aleochara* (Fig. 2 B), *Xylodrepa* (Fig. 1 C), *Megalopinus*, etc. A transverse tergal suture (ridge) is present only in *Apatetica*, *Oxytelus* (Fig. 2 F) and *Stenus* (Fig. 2 H). The stigmata of the 1st segment are usually larger than those of the succeeding segments.

Lateral plates. The lateral plate is present in the 1st segment or not. If present, it is usually weakly pigmented and submembranous to weakly sclerotized. No modification is found on the lateral plate.

Sternum. The 1st sternum has hitherto been considered to be completely lost in the Staphylinoidea, but the presence is ascertained by careful examination of the base of the abdomen. It is much reduced and is connected with the 2nd sternum by membrane. It is present in *Xylodrepa* (Fig. 3 B), *Nodynus*, some Omaliinae,

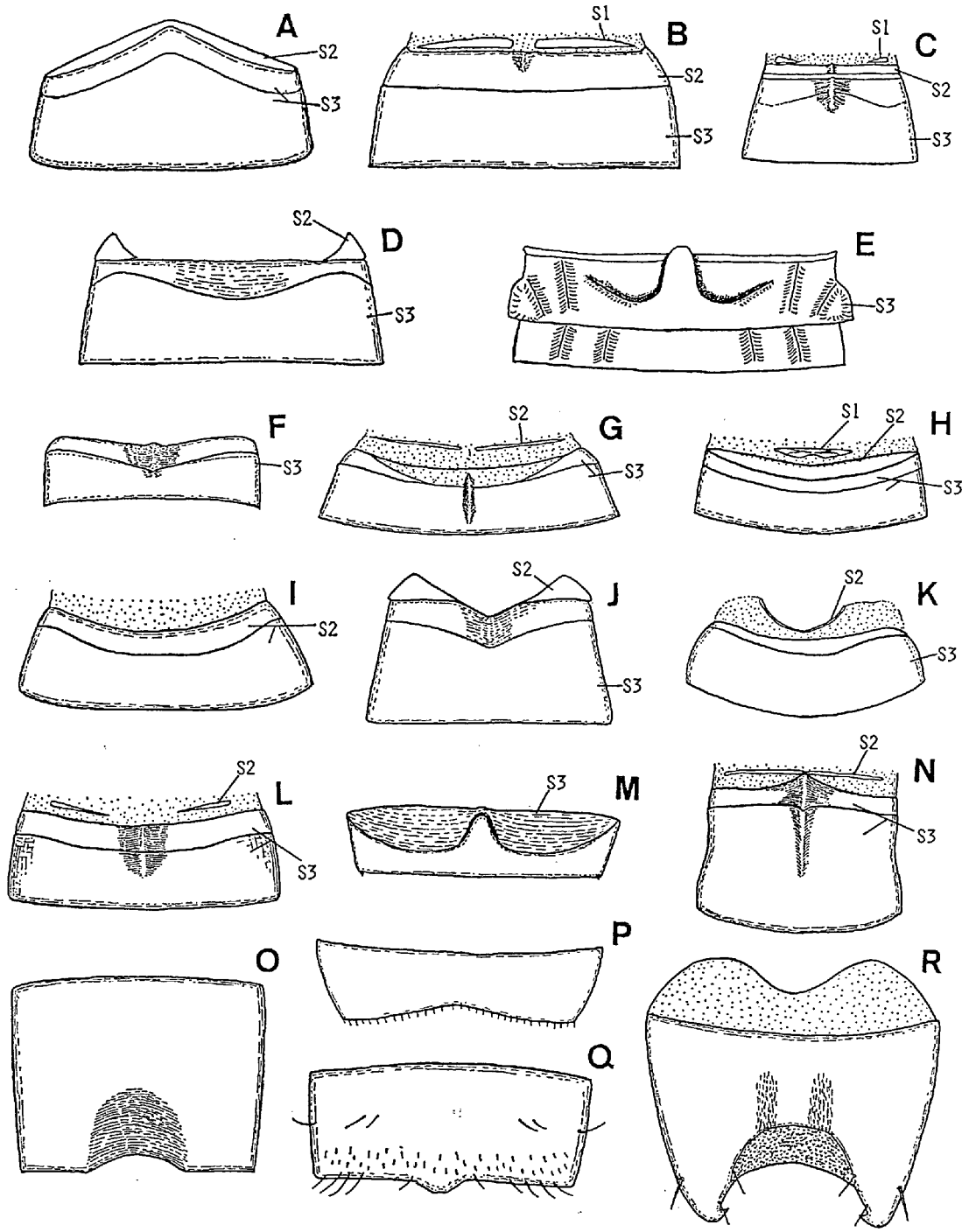


Fig. 3. A, *Aleochara curtula*; B, P, *Xylodrepa sexcarinata*; C, *Paederus parallelus*; D, *Platydracus paganus*; E, *Micropeplus fulvus*; F, R, *Tachinus japonicus*; G, *Megarthrus japonicus*; H, *Oxyporus japonicus*; I, Q, *Oxytelus nigriceps*; J. *Nudobius apicipennis*; K, *Pseudopsis watanabei*; L, *Philydrodes aquatilis*; M, *Euconnus fustiger*; N, O, *Stenus alienus*. A–N, Basal part of abdomen in ventral view; O–R, 7th sternum of male.

some Tachyporinae and *Paederus* (Fig. 3 C) as a pair of linear plates, or in *Oxyporus* (Fig. 3 H) and *Megalopinus* as a linear plate.

4. *Second abdominal segment*

Tergum. The 2nd tergum is usually narrower than or as broad as the 1st, and is shorter than the 3rd. It is a transverse and subrectangular plate, and is submembranous to moderately sclerotized. The anterior margin is straight (Figs. 1 C, F–G, 2 A, G), gently arcuate (Fig. 2 B, H), bisinuate (Fig. 2 C, E–F, I) or broadly emarginate (Fig. 1 I), and the transverse tergal suture is present or not.

Lateral plates. The lateral plate is present in the 2nd segment or not. If present, the pigmentation and sclerotization are similar to those of the lateral plate in the 1st segment. No modification is found on the lateral plate.

Sternum. There are three kinds of conditions for the structure of the 2nd sternum. First, the 2nd sternum is represented by a transverse and very short plate. It is partially fused with the 3rd (GPC) and a longitudinal carina is often present on the middle. This condition is found in *Nicrophorus*, *Xylodrepa* (Fig. 3 B), Piestinae, Osoriinae, Oxytelinae, many Tachyporinae, Paederinae (Fig. 3 C), Aleocharinae (Fig. 3 A), and Oxyporidae (Fig. 3 H) but pselaphids. The 2nd sternum is very thin in *Stenus* (Fig. 3 N) and *Pseudopsis* (Fig. 3 K) and is connected with the 3rd by membrane. It is well developed and similar in shape to the 3rd in some Oxytelinae (Fig. 3 I).

Secondly, the 2nd sternum is composed of a pair of triangular plates and they are situated laterally and completely separated. This is found in *Catops*, the Proteininae (Fig. 3 G), Omaliinae (Fig. 3 L), Xantholininae (Fig. 3 J) but Othiini, *Lasinus* (Fig. 1 D) and Staphylininae (Fig. 3 D). Thirdly, the 2nd sternum has completely disappeared in the Catopiaria but *Catops*, Micropeplinae (Fig. 3 E), Scaphidiidae (Fig. 1 E), Scydmaenidae (Fig. 3 M) and many pselaphids.

Consequently, the hologastrous, haplogastrous as well as cryptogastrous types are found for the structure of the 2nd sternum.

5. *Third to 7th abdominal segments*

The 3rd to 7th segments of the abdomen are subparallel-sided, gradually narrowed (GPC) or gradually broadened posteriorly. They are sometimes broadest at the median 4th or 5th segment, and then gradually narrowed both anteriorly and posteriorly. They are strongly narrowed posteriorly in many Tachyporinae (Fig. 2 A). The 7th segment is sometimes about half as broad as the 3rd at the posterior margin. The 4th to 10th segments all are completely telescoped into the 3rd in dried condition in an extreme case.

The proportions of the 3rd to 7th segments in length are various from one genus to another. The segments are subequal to one another in length (GPC) and the condition is widely found in the Staphylinoidea. The 7th tergum is called "propygidium" in the descriptive study.

Terga. Each of the 3rd to 7th terga is transversely rectangular to trapezoidal in shape, and a transverse tergal suture runs along the basal margin.

The 3rd to 7th terga are subject to various modifications. A pair of longitudinal carinae run parallel on the middle of the 5th tergum for receiving inner margins of the elytra between them in *Nicrophorus*. The median and a pair of midlateral longitudinal carinae are present on each of the 4th to 7th terga in the Micropeplinae (Fig. 1 F). The 3rd tergum has a deep fovea near the center in *Thoracophorus*. The reticulate or carinate sculptures are found on the 3rd to 7th terga in *Oligota*. A similar reticulation is found also on the 3rd to 6th terga in *Palaminus*. A longitudinal ridge is present on the middle of the 7th tergum and is about half times as long as the 7th segment in the male *Tachyusida*. The reverse V-shaped sculptures are present on the 3rd to 7th terga in the Megalopininae.

Lateral plates. The lateral plates are one- or two-paired in each of the 3rd to 7th segments, and each is very elongate rectangular or subtriangular in shape, or they are completely fused with terga or absent. If they are two in number in one side, they are longitudinally divided in the 3rd to 6th segments and are longitudinally, obliquely or horizontally divided in the 7th. When the lateral plate is divided obliquely, the demarcation line always runs from the anterolateral corner to near the middle of the inner margin.

The modifications are rarely found on the lateral plates. The foveae are moderate in size on the inner lateral plates of the 3rd to 6th segments in the Megalopininae.

Sterna. The 3rd to 7th sterna are more convex and a little broader than the terga, and each is transversely trapezoidal in shape in ventral view and is the same in length as the corresponding tergum (GPC) in general. But the 3rd sternum is 3 to 5 times as long as the 4th sternum and about 4 times as long as the 3rd tergum in the Scaphidiidae (Fig. 1 B, E). A transverse suture runs along the basal margin in each sternum (GPC).

The basal part of the 3rd sternum is often provided with a median longitudinal carina and the sides are symmetrically and shallowly concave and smooth for receiving hind coxae as in Fig. 3 C, E, M. The carinae are various in shape and length from group to group. The median carina is, however, absent in the Oxytelinae, Pseudopsinae (Fig. 3 K), Oxyporinae (Fig. 3 H) and Aleocharinae (Fig. 3 A).

There are various modifications on the male 7th sternum. For example, the posterior margin is arcuately emarginate in the male of some groups (Fig. 3 O–P, R). The emargination is wide and very shallow (Fig. 3 P) in general, but is moderately deep in *Tachinus* (Fig. 3 R) and *Derops*. The surrounding area of this emargination is provided with setae characteristically arranged in *Derops*, *Tachinus* (Fig. 3 R), etc. This area is provided also with blackish and peg-shaped setae arranged in a row in *Derops*, *Lithocharis* and *Astenus*, with a tuft of golden yellowish hairs in *Amichrotus*, and with blackish small denticles in *Derops*, *Domene*, *Lobrathium*, etc.

The posterior margin projects posteriorly at the middle of the male 7th sternum in some *Oxytelus* (Fig. 3 Q). The 7th sternum is provided with a bundle of hairs like horsetail near the center in the male *Tympanophorus*.

The other modifications are found on the 3rd to 7th sterna. Four or 5 longitudinal carinae are present in each of the 3rd to 7th sterna in the Micropeplinae. The 3rd to 6th sterna are similarly reticulate as on the corresponding terga in *Palaminus*. The 3rd to 7th sterna are similarly sculptured as on the corresponding terga in the Megalopininae.