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Morphology and Function of a Possible Stridulation Apparatus in Genus *Hydrovatus* (Coleoptera, Dytiscidae)

(Contribution to the study of Dytiscidae 61)

by O. Biström

Abstract: Five principally different states of a possible stridulatory file, exhibited by the males of about 80 *Hydrovatus* Motschulsky species, are distinguished, briefly described and SEM-illustrated. The file-feature has the same basic location on the body (frontally on male metacoxa), and is a synapomorphy for five species groups of *Hydrovatus*. Previously unrecognized body-structures with a probable function as plectrum are presented. Detection of possible new plectrum-structures indicates that many species having a file but no visible plectrum may lack stridulation.

Key words: Coleoptera Dytiscidae – *Hydrovatus* – stridulation apparatus.

Introduction

Different morphological structures in Coleoptera are interpreted as organs for stridulation, despite the absence of recordings of the sound produced. This is especially true for members of *Hydrovatus* that have files which consist of ridges located close to each other and that resemble the stridulatory organs in other groups of insects in which stridulation has been verified.

The possible stridulatory apparatus of some *Hydrovatus* species has seldom been discussed, although there are plenty of articles dealing with sound-production in different insects. For example, BALFOUR–BROWNE (1940) provided a brief description of the structure and also gave an explanation how the stridulation is carried out, on the basis of *H. cuspidatus* (Kunze) and *H. clypealis* Sharp. YOUNG (1963) noted the apparatus in two Palearctic species of *Hydrovatus* and suggested that the structure forms part of a stridulatory organ. Most probably by mistake, LARSON & PRITCHARD (1974) listed the genus *Hydrovatus* among dytiscids which exhibit their stridulatory organs on the metacoxa and metafemur (merely a superficial examination reveals that the plectrum, if present, is located on the mesofemur). Finally, AIKEN (1985) listed in his survey of sound-production by aquatic insects at least 17 dytiscid genera which have been proposed to possess stridulatory structures, one of which was *Hydrovatus*.

The recently completed revision of the genus *Hydrovatus* confirms the suggestion of LARSON & PRITCHARD (1974) that the possible stridulatory apparatus is exhibited in many different species but is absent from all American members of the genus (BISTRÖM 1996/1997).

The objectives of the present article is to present the morphological variation in possible stridulatory structures of *Hydrovatus* and discuss the possible mode of function on the basis of the morphological appearance.

Location and morphological variation in file structures

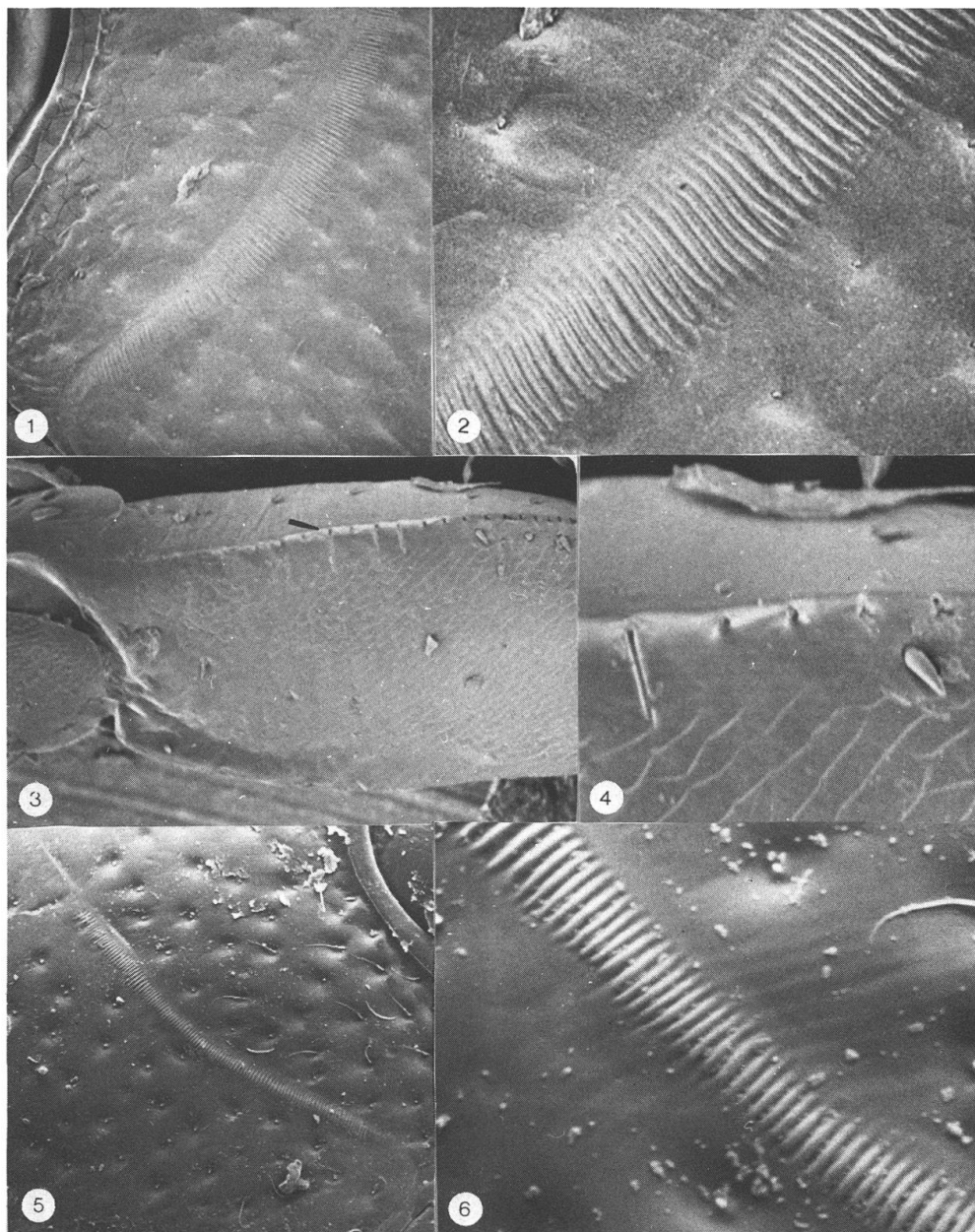
The function of stridulatory structures in *Hydrovatus* probably is to contribute to sound production in connection with courtship behaviour since only males are provided with files. Of the approximately 200 recognized species (BISTRÖM 1996/1997) almost 80 species have files. These are divided into five species groups. In all file-provided species, the location of the structures is the same. Additionally, all the main types of files presented below are regarded as derivations of a similar ground-plan, which definitely indicates synapomorphy of the structure.

File structures, when present, are always located ventrally on the male on both sides at the fore region of the metacoxa. Despite modifications exhibited, the file always covers a rather narrow, moderately curved area (eg. Fig. 1). The main types of file may be distinguished as follows:

a) The most common file is a quite narrow structure, consisting of numerous, almost parallel, minute ridges, which are difficult to distinguish with magnification of less than $100\times$. The total number of separate ridges per file is approximately 100. There is slight variation in the width of the file (*H. nigrita* Sharp; Figs 1–2; *H. seminarius* Motschulsky; Figs 5–6). This kind of file is considered the most plesiomorphic type.

b) A considerable number of species have files with a reduced number of ridges (as few as 10). The size and placement of separate ridges varies randomly (*H. confertus* Sharp; Figs 7–8). The shape of a separate ridge is most often elongated but species with more rounded ridges also exist.

c) A separate morph (possibly a good species) of *H. deserticola* Guignot (the so called “*H. fallax*-morph”) exhibits extreme ridge reduction (three ridges per file) and modification. The ridges are



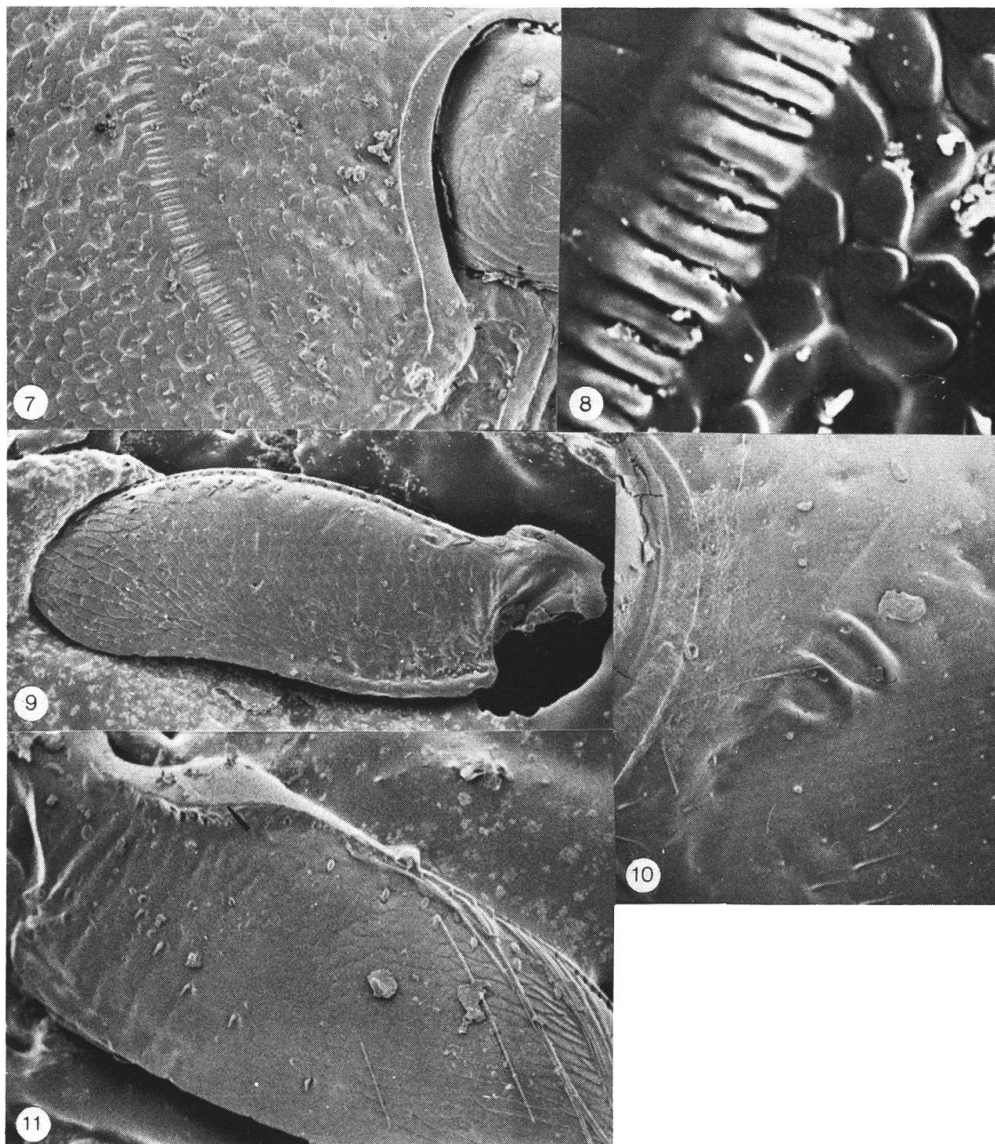
Figs 1–6: Possible stridulation apparatus in *Hydrovatus nigrita* (1–4) and *H. seminarius* (5–6). 1, file, 150 \times . 2, file, 450 \times . 3, mesofemur with possible plectrum at arrow, 200 \times . 4, possible plectrum, 700 \times . 5, file, 200 \times . 6, file, 1000 \times .

greatly enlarged (Fig. 10). (Note that this is not to be considered a description of a new species.)

d) A few Oriental-Australian species have the ridges located on a slightly elevated “platform”. In such cases the ridges are strongly reduced and almost obliterated (*H. enigmaticus* Biström; Fig. 12) or

sometimes even totally absent (a glabrous area at the elevated location of the file).

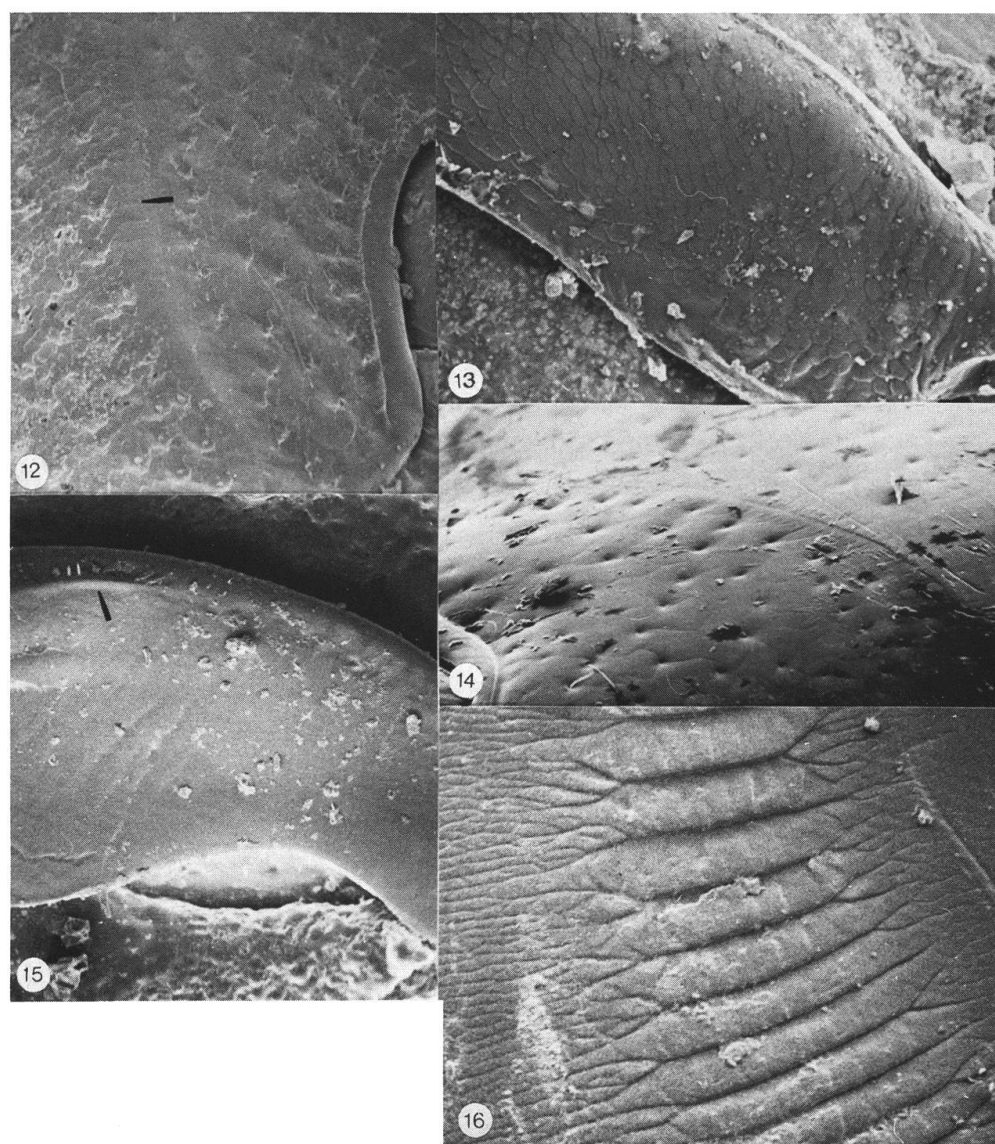
e) In a few species the file structures are suggested to have been totally lost by reduction (for instance *H. rufescens* Motschulsky; Fig. 14). The systematic placement of these few species among file-provided *Hydrovatus* species is supported by their possession of other systematically important morphological features (Biström 1996/1997).



Figs 7–11: Possible stridulation apparatus in *Hydrovatus confertus* (7–9) and the “*H. fallax*-morph” of *H. deserticola* (10–11). 7, file, 200 ×. 8, file, 1000 ×. 9, mesofemur, 200 ×. 10, file, 200x. 11, plectrum (at arrow), 300x.

Location of plectrum

The location of the plectrum in *Hydrovatus* has been treated solely by BALFOUR-BROWNE (1940), who suggested that the posterior edge of the metafemora has a plectrum function. His conclusion was possibly based on the fact that he had found no alternative suitable structures. My studies (all species have been examined but not by the SEM-technique), indicate that many species provided with files lack



Figs 12–16: Possible stridulation apparatus in *H. enigmaticus* (12–13). 12, rudiment of file-ridge at arrow, 150 ×. 13, mesofemur, 300 ×. 14, anterior part of male metacoxa lacking file, *H. rufescens*, 200 ×. 15, metacoxa of *Laccophilus hyalinus* with plectrum (at arrow), 150 ×. 16, stridulation file of *L. hyalinus*, 300 ×.

a plectrum or equivalent structures on the inner surface of the mesofemora (Figs 9, 13). I have, however, detected two species with structures which may have a plectrum function.

In *H. nigrita* there is a minute but quite steep ridge close to the frontal edge suiting comparatively well the location of the file (Figs 1–4). This mesofemoral ridge resembles that exhibited by the diving-beetle species *Laccophilus hyalinus* (Fig. 15), despite considerable differences in the latter's file construction. In *Hydrovatus* species file-ridges are equally steep on each side (e.g. Fig. 6) while in *L. hyalinus* one side is extremely steep and the other hardly at all steep (Fig. 16).

In “*H. fallax*-morph”, there is a strongly built plectrum structure located frontally on the inner side of mesofemur (Fig. 11). The location of this plectrum matches quite well the location of the file on the body.

How is stridulation displayed in *Hydrovatus*?

If the posterior edge of the male mesofemora has a plectrum-function, as suggested by BALFOUR–BROWNE (1940), the stridulation procedure requires movement of the whole mid-leg in a certain position (Fig. 17a–b). This position enables the use of the plectrum only during the mesofemur's forward stroke. My studies by no means exclude the mode of function proposed by BALFOUR–BROWNE. I simply provide an alternative model in which those *Hydrovatus* species with their plectrum frontally on the inner surface of the mesofemora may stridulate without bending the midleg to a position almost vertical against the body. Furthermore, the apparatus can be used on the backward stroke, or, in case of *H. nigrita*, with strokes in both directions (Fig. 17c).

What about those species having a distinct file but lacking a plectrum, as described in this article? Either they stridulate as suggested by BALFOUR–BROWNE, or they have lost the ability, and the file can be regarded as a rudiment.

This preliminary survey presents some questions to be answered in forthcoming more detailed studies, which ought to include recordings of stridulation and careful behavioural studies of how the mesofemora are moved during the stridulation procedure:

1. Does sound-production occur among *Hydrovatus* at all?
2. Is sound-production delimited to those species with a plectrum frontally on the mesofemur?

3. Is sound-production possible with asymmetric files within species?
4. Is there a “secondary” function of the file in species lacking a plectrum?
5. Is the existence of other structures with a plectrum function not yet detected?

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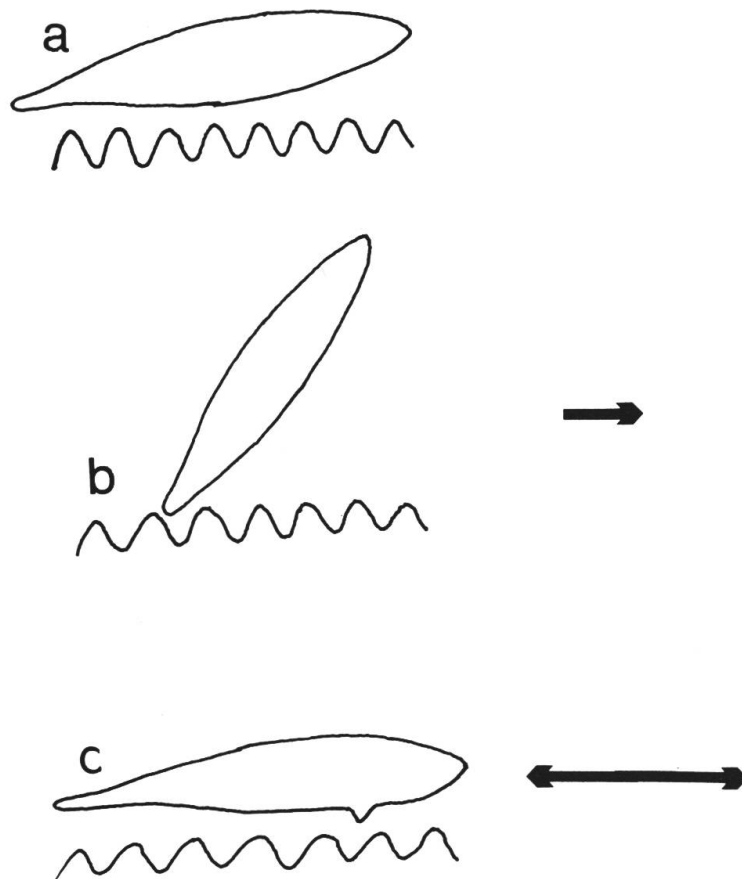


Fig. 17: Schematic illustrations of alternative modes of stridulation in *Hydrovatus*. a, file and mesofemur (transection) in normal position. b, stridulation procedure as suggested by Balfour-Browne (1940). c, alternative mode of stridulation. Arrow indicates direction of mesofemur movement under stridulation.

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