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Study on the Systematic Position of *Systolosoma breve* Solier (Adephaga: Trachypachidae) Based on Characters of the Thorax

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Internal and external thoracic features of *Systolosoma breve* Solier were examined and interpreted phylogenetically. The irregular pattern of the elytra is considered as an autapomorphy of *Systolosoma*. The rounded apex of the prosternal process, the elongated, cranial part of the metasternal process which is rigidly interlocked with the deeply excavated, separate posterior part of the meso"sternal" hexagonal groove, the tendency towards reduction of flight muscles, and the absence of M. dorsoventralis secundus and M. sterno-episternalis are possible synapomorphies of *Trachypachus* Motschulsky and *Systolosoma* Solier. Partial reduction of the metasternal transverse ridge and fusion of the mesal metacoxal walls are considered synapomorphies of *Trachypachus* + *Systolosoma* + Dytiscoidea. This phylogenetic interpretation would imply that the subcubital setal binding patch is secondarily absent from adults of *Systolosoma*. The condition of the mesepimeron and metepimeron is in agreement with the presumptive groundplan condition of Adephaga.

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Introduction

The monophyly of Trachypachini (holarctic *Trachypachus* Motschulsky and neotropical *Systolosoma* Solier) has never been seriously questioned so far. This may be partly due to the great overall similarity of adults of both taxa, which is of course no argument for a close phylogenetic relationship. The tribe Trachypachini is characterized by the lack of dense pubescence on the distal antennomeres according to Lindroth (1969). However, this feature is almost certainly plesiomorphic, and is also characteristic for Hydradephaga. Recently, several arguments which may point towards paraphyly of Trachypachini were pointed out by Crowson (in litt.): a subcubital setal binding patch is present in *Trachypachus* but absent from *Systolosoma;* a scrobal seta on the outer mandibular margin is present in *Systolosoma,* wheras a long tubular duct opening is found in *Trachypachus;* the mesepisterna reach the mesocoxal cavities in adults of *Trachypachus* but not in *Systolosoma* (?). The present study of thoracic structures is understood as a test of the present placement of *Systolosoma* closest to

Trachypachus. It is evident that a closer examination of more character systems will be needed for a final systematic positioning of *Systolosoma*. Especially the discovery of the larva of *Systolosoma* should be regarded as a high priority project.

Material and Methods

Two dried specimens of *Systolosoma breve* were soaked in 70 % ethanol for dissection. They were collected in pitfall traps (Chile: Provincia de Valdivia 6 km NW of Choshuenco Pte. Blanco: 39° 48′ S 72° 05′ W Site A, El. 180 m, 6-XII-1987, Ashworth, Fugiseth, Malischke). A Berlese apparatus was used for collecting specimens of *Trachypachus holmbergi* (Canada, Alberta, Edmonton, Univ. of Alberta campus, 9-VIII-1991, R.G. Beutel). They were preserved in Kahle's, and stored in ethanol. Drawings were made using an ocular grid (stereo microscope).

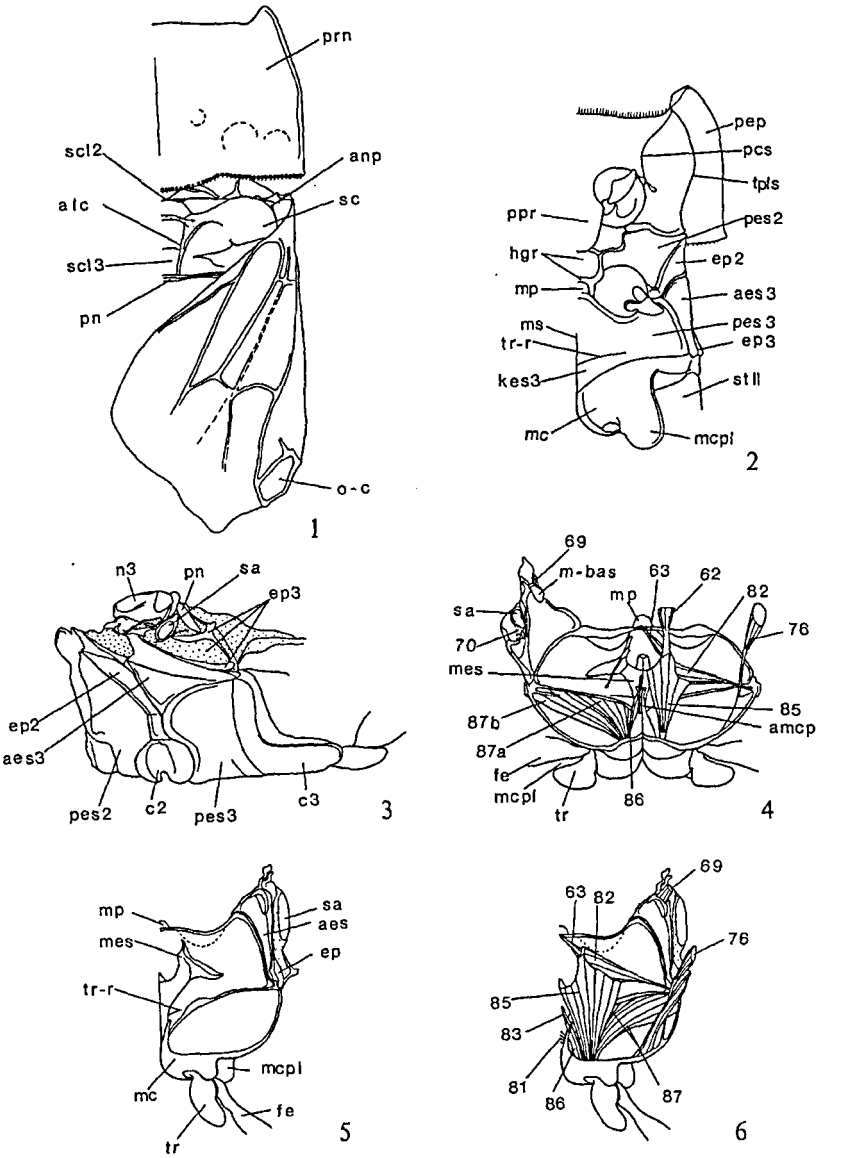
Morphological results

Prothorax (Figs. 1-2)
Low grade motility type prothorax as defined by Hlavac (1975). Pronotum with median impressed line, fairly large, circular posterolateral impressions, and a regular row of short spines along the posterior margin. Prosternal process slightly shortened and rounded apically. Procoxal cavities open-bridged. Both protibial spurs in terminal position, setal band of the antenna cleaning organ fairly short.

Mesothorax (Figs. 1-3)
Mesonotum narrow, almost completely concealed by the pronotum. Triangular scutellar shield exposed. Meso"sternal" hexagonal groove (Beutel, 1991) divided into a cranial part which articulates with the prosternal process, and a deeply excavated caudal part which articulates with the elongated metasternal process. Broad mesepimeron contacts mesocoxal cavities. A transverse impressed line close to the base of the mesepimeron may give the impression of conjunct mesocoxal cavities. Elytra with irregular pattern (Lindroth, 1960).

Metathorax (Figs. 1-4)
Metanotum rather flat and without modifications. Characteristic metasternal process with separate, elongated cranial part which articulates with the deeply excavated posterior part of the meso"sternal" hexagonal groove. Transverse ridge laterally reduced. Anepisternum does not contact the mesocoxal cavities. Metepimeron narrow, triangular, and parallel to the body axis. Metacoxae broad, clearly separating the metepimeron from the 1st visible abdominal sternite. Cranial metacoxal walls fused to the katepisternum 3. Mesal metacoxal walls fused*, with long craniomesal processus. Metacoxal plates fairly extensive. Metendosternite moderately large, with deep anterior incision, pouch-like lateral arms, and a well developed anteromesal process. Hind wings without subcubital setal binding patch.

* The metacoxal walls become detached from each other and from the katepisternum when specimens of Trachypachini or Dytiscoidea are treated with hot KOH (Beutel and Belkaceme, 1986).



Figs. 1-6. 1-4. *Systolosoma breve;* 1. thorax, dorsal view. alc-alacrista, anp - anteriot notal process, o-c - oblongum cell, pn - postnotum, prn - pronotum, sc - scutum, scl - scutellum; 2. thorax, ventral view. aes - anepisternum, ep - epimeron, hgr-meso"sternal" hexagonal groove, kes - katepisternum, mc - metacoxa, mcpl - metacoxal plate, mp - metasternal process, ms - median suture, pcs - paracoxal suture, pes - preepisternum, ppr-prosternal process, st II - abdominal sternite II, tpls - tergopleural suture, tr-r - transverse ridge; 3. meso- and metathorax, lateral view; 4. metathorax, dorsal view, metanotum and degenerated indirect flight muscles removed; amcp - anteromesal coxal processes, c - coxa, fe - femur, m-bas - muscle disc of basalare, mes - metendosternite, *n* - notum, sa - subalare, t - tendon, tr - trochanter, muscles see chapter metathoracic musculature. 5-6. *Trachypachus holmbergi,* metathorax, dorsal view; 5. all muscles removed; 6. only degenerated indirect flight muscles removed.

Metathoracic musculature (nomenclature: Larsén, 1966)
The presence or absence of a few muscles could not be clarified due to the poor condition of the specimens at hand.

Dorsal muscles
M 60: M. metanoti primus
S. breve: degenerated (few muscle fibres are imbedded in fatty tissue)
T. holmbergi: degenerated (Beutel, 1988)
M 61: M. metanoti secundus
S. breve: degenerated
T. holmbergi: degenerated (Beutel, 1988)
Ventral muscles (Figs. 4, 6)
M 62: M. metasterni primus
S. breve: fan-shaped with a short broad tendon (Fig. 4)
T. holmbergi: fan-shaped, directly attached to anterior projection of the metendosternite (Fig. 6; Beutel, 1988)
M. 63: M. metasterni secundus
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6; Beutel, 1988)
Dorsoventral muscles
M. 64: M. dorsoventralis primus
S. breve: degenerated (?)
T. holmbergi: degenerated (Beutel, 1988)
M. 65: M. dorsoventralis secundus
S. breve: absent
T. holmbergi: absent (Beutel, 1988)
M. 66: M. dorsoventralis tertius
S. breve: absent
T. holmbergi: absent
Lateral muscles (Figs. 4, 6)
M. 67: M. pleura-praealaris
S. breve: ?
T. holmbergi: present (Fig. 6; Beutel, 1988)
M. 69: M. noto-basalaris
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6; Beutel, 1988)
M. 70: M. epimero-subalaris
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6; Beutel, 1988)
M 71: M. pleura-alaris
S. breve: ?
T. holmbergi: present (Fig. 6; Beutel, 1988)
M. 72: M. sterno-episternalis
S. breve: absent
T. holmbergi: absent (Beutel, 1988)
M. 73: M. sterno-basalaris
S. breve: degenerated
T. holmbergi: degenerated (Beutel, 1988)

Leg muscles (Figs. 4, 6)
M. 75: M. noto-coxalis anterior
S. breve: degenerated
T. holmbergi: degenerated (Beutel, 1988)
M. 76: M. noto-coxalis posterior
S. breve: well developed (Fig. 4)
T. holmbergi: well developed (Fig. 6; Beutel, 1988)
M. 78: M. coxa-basalaris
S. breve: degenerated
T. holmbergi: degenerated (Beutel, 1988)
M. 79: M. coxa-subalaris
S. breve: degenerated
T. holmbergi: degenerated (Beutel, 1988)
M. 81: M. furca-coxalis anterior
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6; Beutel, 1988)
M 82: M. furca-coxalis lateralis
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6; Beutel, 1988)
M. 83: M. furca-coxalis posterior
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6; Beutel, 1988)
M. 85: M. furca-trochanteralis
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6)
M. 86: M. coxo-trochanteralis medialis
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6)
M. 87a, b: M. coxo-trochanteralis lateralis
S. breve: present (Fig. 4)
T. holmbergi: present (Fig. 6)

Discussion

Prothoracic features
The prosternal process is very similar to that of *Trachypachus* (Beutel, 1991; Fig. 2). The rounded apex may be considered as a common derived feature of both groups. Pointed prosternal processes are found in most Dytiscoidea and in most "basal carabids" such as *Metrius* Eschscholtz, *Opisthius* Kirby, Carabini etc., and are therefore considered plesiomorphic. Open-bridged procoxal cavities and terminal protibial spurs are groundplan features of Adephaga (Beutel, 1991).

Mesothoracic features
The hexagonal meso"sternal" groove is probably a derived groundplan feature of Adephaga excl. Gyrinidae. The subdivision into a cranial part and a deeply excavated caudal part is a possible synapomorphy of *Systolosoma* and *Trachypachus. A* similar condition has not been described for other members of

Adephaga so far. The contact between prosternal process and meso"sternal" groove guarantees good horizontal wedge pushing abilities (Evans, 1982). The contact between the broad mesepimera and the mesocoxal cavities is a groundplan feature of Adephaga and is also found in *Trachypachus* (Beutel, 1991).

Metathoracic features

The flat metanotum of *Systolosoma* and *Trachypachus* indicates modest flying abilies of adults with developed flight muscles. The elongated cranial part of the metasternal process may be considered as a possible common derived feature of *Trachypachus* and *Systolosoma.* Together with the deeply excavated posterior section of the meso"sternal" hexagonal groove, it provides a very rigid mesothoracic-metathoracic interlocking mechanism. An unmodified, rounded metasternal process is found in other adults of Adephaga examined (Beutel, 1991; Figs. 3-10, 12-22) with the exception of *Hiletus fossulatus* Jeannel. The lack of contact between anepisternum 3 and mesocoxal cavity in *Systolosoma* and *Trachypachus (!)* is almost certainly plesiomorphic. Fusion of the anterior metacoxal wall with the katepisternum, fusion of the the mesal metacoxal walls, and the lateral reduction of the meta"sternal" transverse ridge are probably synapomorphies of Trachypachidae + Dytiscoidea (Beutel and Roughley, 1988). This implies secondary absence of the subcubital setal binding patch from the hind wings of *Systolosoma.* Broad metacoxae, and a narrow, triangular ventral metepimeral sclerite which is parallel to the body axis as found in adults of *Systolosoma* and *Trachypachus* (Figs. 4, 5) are groundplan features of Adephaga (Beutel, 1991).

Muscular features

Systolosoma and *Trachypachus* show a typical pattern of reduction of indirect metathoracic flight muscles. It is likely that well developed flight muscles are found in a certain percentage of specimens and in newly emerged adults. This is suggested by the presence of a full set of small, direct flight muscles in *T. holmbergi* and probably in *S. breve.* The tendency towards degeneration of flight muscles and the correlated flat metanotum may be considered as a common derived feature of both genera. However, similar reduction patterns are a rather common feature among Adehaga (e.g. *Amphizoa lecontei* Matthews; Beutel, 1988). Complete absence of M. dorsoventralis secundus and M. sterno-episternalis are a possible synapomorphy of *Systolosoma* and *Trachypachus* , however those muscles are also missing in other taxa (Larsén, 1966). The presence of 3 pairs of furca-coxal muscles in both genera is plesiomorphic (Beutel and Roughley, 1988). Coxotrochanteral muscles are arranged in a very similar, presumably plesiomorphic manner, in *T. holmbergi* and *S . brevis* .

Conclusion

The results of this study suggest that *Systolosoma* and *Trachypachus* are sistergroups and that the tribe Trachypachini should be maintained. This is in agreement with Lindroth (1960) who has emphasized the great similarity of the male genitalia. The presence of symmetric parameres with a broad basal half, abruptly narrow-

ing into the long parallel-sided apex is probably a synapomorphy of both genera. Structural differences (presence of a mandibular duct opening in *Trachypachus*, scrobal seta in *Systolosoma* etc.) have to be considered as autapomorphies and are not in contrast with the proposed monophyly of Trachypachini.

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