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THE CONSTRUCTION OF GNATHEMA IN THE ADULT WATER MITE *HYDRODROMA DESPICIENS* (MULLER, 1776) (ACARIFORMES, HYDRODROMIDAE)

СТРОЕНИЕ ГНАТЕМЫ ВЗРОСЛОГО ВОДЯНОГО КЛЕЩА *HYDRODROMA DESPICIENS* (MULLER, 1776) (ACARIFORMES, HYDRODROMIDAE)

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Ключевые слова: *Hydrodroma despiciens*, гнатема, ротовые органы

ABSTRACT

The description of the mouth apparatus of the adult water mite *Hydrodroma despiciens* (Muller, 1776) is given. The analysis of the author's data and literature sources suggests that in *H.despiciens* the gnathema can be classified as the piercing-cutting-sucking one.

РЕЗЮМЕ

В статье приводится описание строения ротового аппарата половозрелого водяного клеща *Hydrodroma despiciens* (Muller, 1776). Проведенный анализ собственных материалов и литературных данных позволил сделать вывод, что гнатема *H.despiciens* может быть классифицирована как колюще-режуще-сосущая.

Mitchell [1962] described and illustrated some peculiarities of the gnathema* structure in *H.despiciens* in his work on the comparative analysis of the mouthparts of water mites. Tuzovsky [1987] described the setation of *H.despiciens* in his extensive monograph on the morphology and post-embryonic development of water mites. Wiles [Wiles, 1982] studied the diet and the elements of the feeding behavior of *Hydrodroma*.

This paper presents the detailed analysis of the gnathema microscopic organization in *H.descipiens* by methods of light and electron microscopy.

RESULTS

H.despiciens is red in color, actively swimming mite. It is a typical inhabitant of lentic waters.

The mouth apparatus, or gnathema, is situated on the ventral side of the anterior part of the body (Fig. 1a, 1b; 2a). It presents a complex of organs, which are encircled by a sclerotized gnathema capsule (c, Fig.1b; 2a) and characterized by mixed morphological origin [Lange, 1962; Mitchell, 1962]. Externally the gnathema capsule provides attachment for palps and chelicerae. The pharynx, sclerites, gland ducts, tracheae as well as cheliceral, palpal, and pharyngeal musculature are located inside the capsule.

The deep incurvation of the dorsal wall of the gnathema capsule forms a groove and hypostomal plicae (hpl, Fig. 1b; 2b; 3a). The groove floor is strengthened by epystomal apodemes (eap, Fig. 3a). Two-segmented chelicerae (ch, Fig. 3a) are placed inside the groove. Ventral surfaces of the chelicerae, the floor and walls of the hypostomal groove limit the subcheliceral space (sch, Fig. 3a). The hypostomal groove and subcheliceral space end with the U-shaped apodeme (uap) and accompanying sigmoid pieces, or sigmoids (s, Fig. 3a), in the basal region of the gnathema.

The chelicerae are isolated. They consist of the massive, elongated basal segments and dagger-like movable digits, or chelae (dm), which are opposed by membranous appendages of the distal parts of the basal cheliceral segments (m, Fig. 1b; 2a; 3a). The movable digits of the chelicerae bear laterally and externally raws of small spines. Their articulation with the basal segment is provided by a finger-like projection, or a digital process, of its wall (d)

*"gnathema" is understood by the author as a complex of appendages surrounding the mouth opening sensu A.Lange [1962]

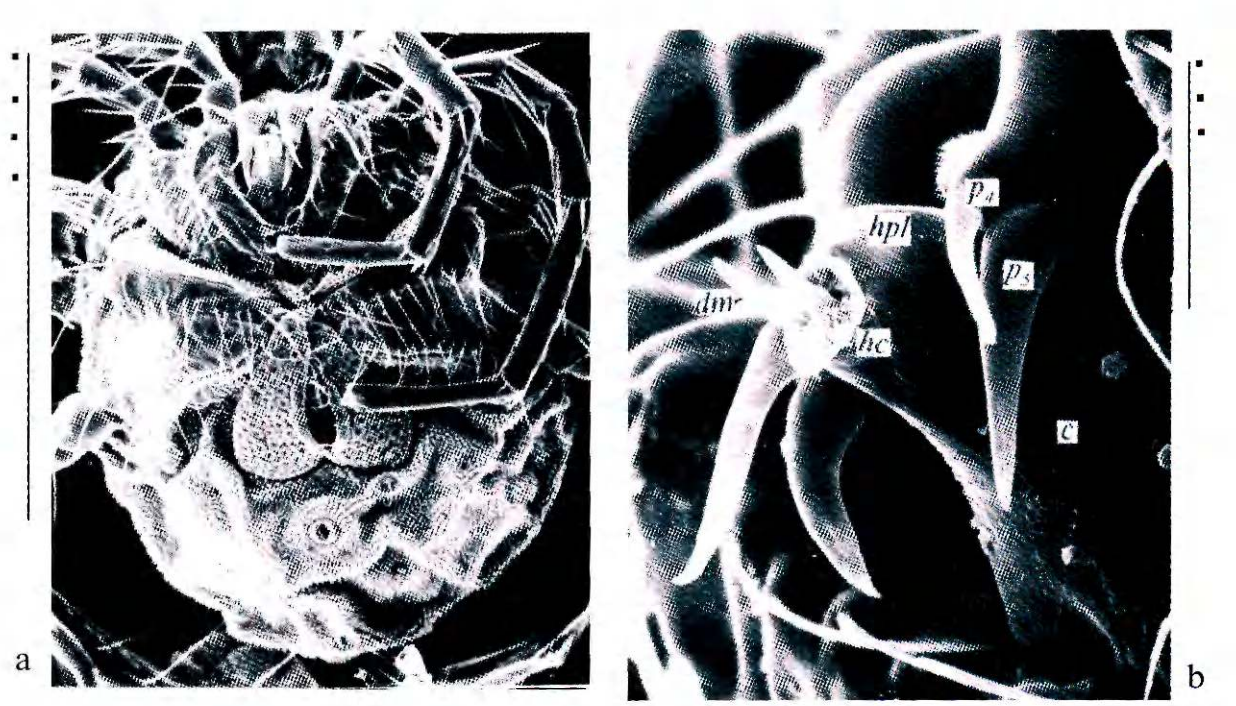

Fig.1. Ventral aspect and the gnathema: a — ventral aspect, male; b — gnathema, lateral side. Scale (μm): for a — 1000; for b — 100. Abbreviations: c — capsule of gnathema; dm — movable digit, or cheliceral claw; hc — hypostomal disc; hpl — hypostomal plica; p_{4-5} — segments of the palp.

Рис.1. Общий вид брюшной стороны и гнатема: a — общий вид брюшной стороны, самец; b — гнатема, вид сбоку. Масштаб (μm): для a — 1000; для b — 100. Обозначения: c — капсула гнатемы; dm — подвижный палец, хелицеральный коготь, хела; hc — гипостомальный диск; hpl — гипостомальная складка; $p_{4\ 5}$ — членики пальпы.

and the corresponding dimple at the basis of the chela (Fig. 3b).

The movement of chelae is induced by elevator and depressor muscles (elev.dm, depr.dm), which are located in the cavities of the basal segments of chelicerae (Fig. 3b). The regular consecutive contractions of these muscles cause partial circles of the chela around the digital process (d) whilst the pointed tip of the cheliceral claw has an arch-like trajectory (Fig. 3b). The kinematical scheme of the articulation of the cheliceral claw and the basal sclerite was analyzed in the earlier paper [Zhavoronkova, 1993]. This form of the cheliceral segment attachment is predominant in water mites as was shown earlier by Hirschmann [1962] and Mitchell [1962].

The protrusion of chelicerae from the hypostomal groove is provided by a sclerite-muscular system, which includes the sclerotized pieces, or sigmoids (s), and the cheliceral protractor muscles (protr.ch). The latter are located between the hind walls of sigmoids and posterior parts of cheliceral basal segment dimples (Fig. 3b). As it was explained by Mitchell [1962], the contraction of cheliceral protractors causes the incomplete rotation of sigmoids relative to their place of attachment to the medial part of the U-shaped apodeme (Fig. 3a, b). The tips of sigmoids reach the anterior part of the cheliceral basal segment dimples and make arch-like movements pushing chelicerae ahead inside the hypostomal groove. The return of chelicerae to the initial position is provided by retractor muscles (retr.ch.), which originate as tendons on the external lateral walls of the cheliceral basal segments and end dorsally close to the gnathema articulation (Fig. 3b). The resulting work of chelicera combines the reciprocal sliding of the basal segment inside the hypostomal groove and the arch-like swinging against the rotation axis center, that is the place where the movable digit articulates with the basal segment of the chelicera.

Stigmae (st), which are open into tracheal shafts (tr, Fig. 3a, d, e), are located dorsally over the basal segments of chelicerae. The stigmal openings are surrounded by sclerotized collars and covered with fine films. Tracheal shafts pass the chelicerae and reach the sigmoid pieces, where they end with the closed cavities (Fig. 3a).

The apical part of the hypostome, or hypostomal disc (hc), is a rounded, somewhat concave plate, which is covered by lingulate papillae and bearing two pairs of setae (h_1, h_2, Fig. 1b; 2b). The preoral opening (por) is located in the center of the hypostomal disc (Fig. 2b). It leads to the subcheliceral preoral cavity. The slit-like mouth (or) is

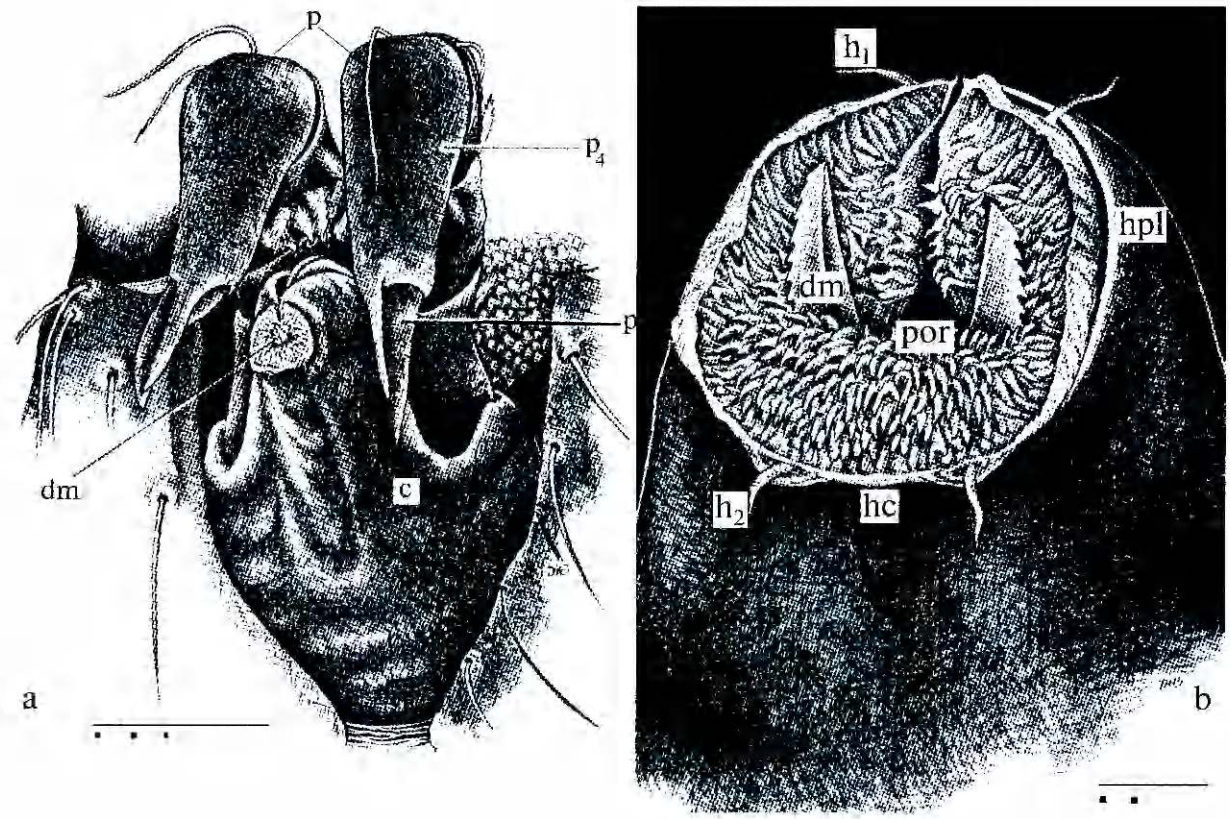

Fig. 2. Gnathema (figures are made using original microphotographs made by SEM): a — ventral aspect; b — apical part of the hypostome. Scale (μm): for a — 100; for b — 10. Abbreviations: c — capsule of gnathema; dm — movable digit, or cheliceral claw; h_{1-2} — hypostomal setae; hc — hypostomal disc; hpl — hypostomal plica; p — palp; p_{1-5} — segments of the palp; por — preoral opening.

Рис. 2. Гнатема (рисунки сделаны по оригинальным фотографиям со сканирующего микроскопа): a — брюшная сторона; b — апикальный участок гипостома. Масштаб (μm): для a — 100; для b — 10. Обозначения: c — капсула гнатемы; dm — подвижный палец, хелицеральный коготь, хела; h_{1-2} — гипостомальные щетинки; hc — гипостомальный диск; hpl — гипостомальная складка; p — пальпа; p_{1-5} — членики пальпы; por — предротовое отверстие.

covered with a small cap-like epistome (e). The mouth opens into a large trough-shaped pharynx (ph). The epipharingeal sclerite (fph) and subpharingeal sclerite (sph) form the pharynx (Fig. 3a). The epipharingeal sclerite is partially fused with the internal part of the ventral wall of the gnathema. The pharyngeal dilator muscles (dil.ph) are attached to the subpharyngeal sclerite with one end and to U-shaped apodeme with the other end (Fig. 3b).

Three ducts of oral glands open into subcheliceral cavity of the gnathema. Two ducts lie parallel to lateral walls of the gnathema capsule (dc). The third one is located medially in the basal part of the gnathema (ds_1, Fig. 3a). The medial duct has a jelly-like covering. All three ducts have their openings close to sigmoids. Parallel lateral ducts open themselves close to external parts of sigmoidal pieces whereas the medial duct's opening is located between sigmoids.

The dorso-lateral gnathema capsule bears five-segmented palps (p, p_{1-5}, Fig. 1b; 2a, 3c). The flexion of palpal segments is attained by the flexor muscles (flex. p_{3-5}, Fig. 3c). The internal hydrostatic pressure provides their return to an initial position [Mitchell, 1962]. The dynamics of the palp is provided by the elevator (elev.p) and depressor muscles (depr.p), which are attached to the basis of the first segment and the basal-lateral part of the capsule (Fig. 3c). The palps are articulated by pretrochanteral system (ptr), which is represented by sclerite protrusions of the gnathema capsule and the first segment basis (Fig. 3c). The tibia of the palp (p_4) bears long, curved, spine-like appendage dorso-distally, which forms a scissors-like subchela together with the fifth segment (p_5) (Fig. 1b; 2a; 3c).

The gnathema capsule is mobile in regard to the body of a mite. The scheme of its movements is in accordance with the mite body longitudinal axis. The capsule can be moved forward by protractor muscles (protr. c) and backward to initial position by retractor muscles (retr.c, Fig. 3c).

CONCLUSION

According to Wiles [1982], *H.despiciens* prey upon chironomid eggs. Its unusually constructed

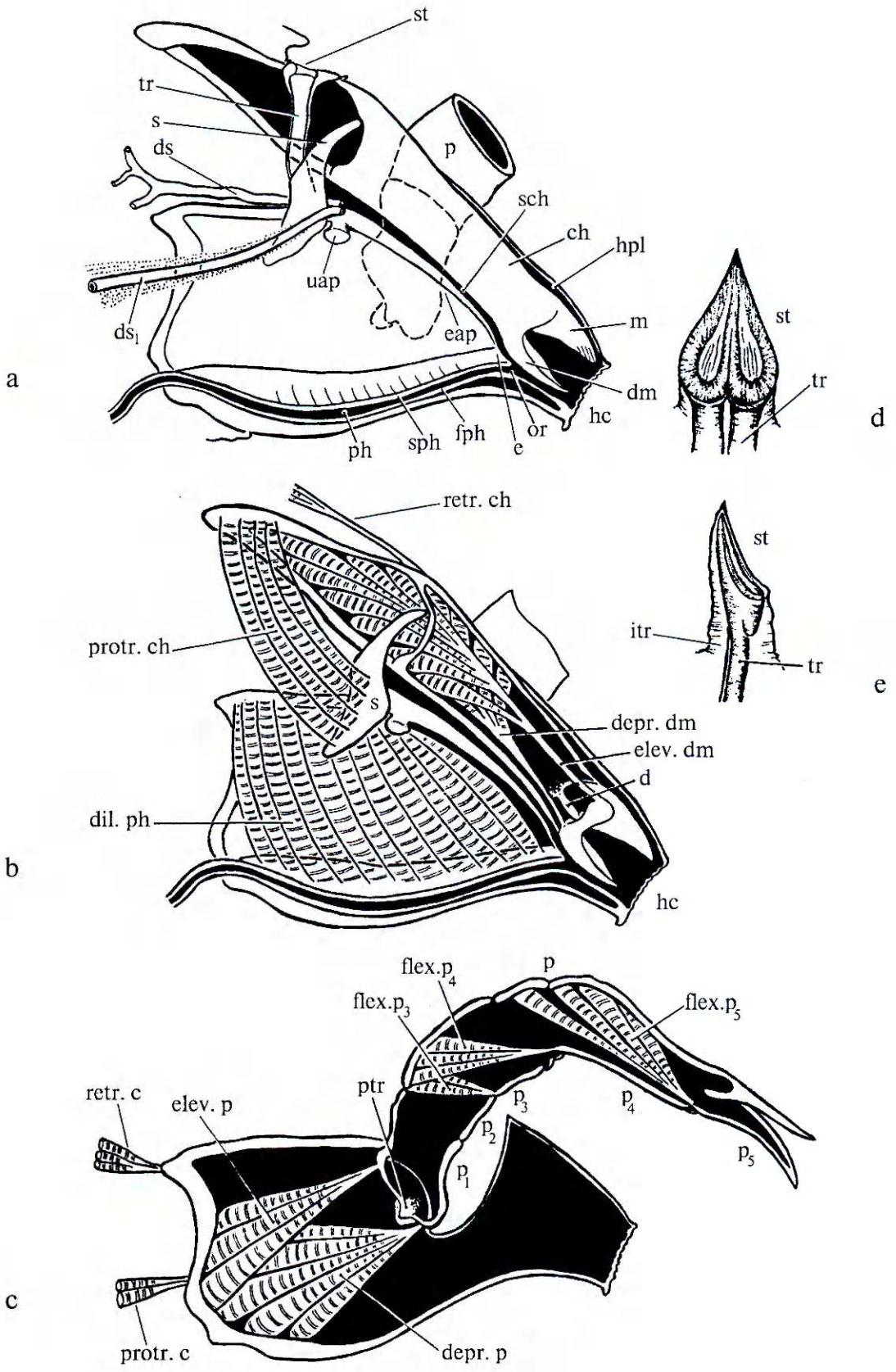

Fig. 3. Construction of the mouthparts: a — sclerotized elements of the gnathema, longitudinal section; b — arrangement of cheliceral and pharyngeal musculature; c — arrangement of palpal musculature; d — stigmae, apical aspect; e — stigmae, lateral aspect.

Рис. 3. Строение ротового аппарата: a — склеротозированные элементы гнатемы, продольный разрез; b — расположение мускулатуры хелицер и глотки; c — расположение мускулатуры пальп; d — стигмы, вид сверху; e — то же, вид сбоку.

palps destroy jelly mass encircling the egg clutch, locate the egg, and tow it to the concave hypostomal disc with the preoral opening in its center. The chelae penetrate and cut the egg coverings. The digestive enzymes are injected into the egg. Then the liquid food is sucked out. This mode of feeding characterizes the gnathema of *H.despicilens* as being piercing-cutting-sucking one.

Water mites are one of a few groups of chelicerate animals, which secondarily occupied the aquatic habitats. The principal shift of the life style was accompanied by the development of numerous adaptations at different levels. Water mites were able to retain the traditional food habit, the external digestion and liquid food consumption, which are a characteristic of terrestrial trombidiform mites. It was a result of corresponding morphological and functional transformations of the mouth apparatus elements.

Wiles [1982] stated that *H.despiciens* is adapted to feeding on chironomid clutches. The palps are adapted for destroying the jelly-like protective coverings and locating the egg tactually. The concave hypostomal disc, which is covered by elastic lingualate papillae, probably adhesive, can provide tough contact between hypostome and the egg surface and the hermetization of the sucking process in water. The development of this mite is also closely associated with chironomids. Wiles [1982] noted that in experimental conditions *H.despiciens* preferred to lay eggs upon chironomid clutches. The larvae of *Hydrodroma* parasitize a large number of different species of their hosts, the chironomid adults [Smith, Oliver, 1976; 1986]. All these data can indicate the close ties between the water mite *H.despiciens* and the Chironomida in the evolutionary process, which could exist since the beginning of the transition of *H.despiciens* ancestral form into aquatic milieu.

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Abbreviations for Fig. 3.

ch — chelicera; d — digital process of the basal segment of chelicera; depr. dm — muscle — depressor of cheliceral claw; depr. p — depressor muscles of the palp; dil. ph — dilator muscles of the pharynx; dm — movable digit, or cheliceral claw; ds — lateral duct of the oral gland; ds_1 — medial duct of the oral gland; e — epistome; eap — epistomal apodeme; elev. dm — elevator of cheliceral claw; elev. p — elevator muscles of the palp; flex.p_{3-5} — flexor muscles of the palp segments; fph — frontal pharyngeal sclerite; hpl — hypostomal plica; itr — cover of the tracheal shaft; m — membranous appendage of chelicera; or — oral opening; p — palp; p_{1-5} — segments of the palp; ph — pharynx; ptr — articulation of the palps claw with the capsule of gnathema; protr. c — protractor muscles of the gnathema capsule; protr.ch — protractor muscles of chelicerae; retr.c — retractor muscles of the gnathema capcule; retr. ch — retractor muscles of the chelicera; s — sigmoid piece; sch — subcheliceral space; st — stigma; sph — subpharyngeal sclerite; tr — tracheal shaft; uap — U-shaped apodeme.

Буквенные обозначения на рис. 3.

ch — хелицера; d — внутренний пальцеобразный вырост стенки базального сегмента хелицеры; depr.dm — мышцы-опускатели подвижного пальца; depr.p — мышцы-опускатели пальпы; dil.ph — мышцы-расширители глотки; dm — подвижный палец, хелицеральный коготь, хела; ds — латеральный проток оральной железы; ds_1 — медиальный проток оральной железы; e — эпистом; eap — эпистомальная аподема; elev.dm — мышцы-подниматели хелы; elev. p — мышцы-подниматели пальпы; flex. p_{3-5} — мышцы-сгибатели члеников пальп; fph — надглоточный склерит; hc — гипостомальный диск; hpl — гипостомальная складка; itr — оболочка трахеальных стволов, образованная выпячиванием переднеспинного участка покрова; m — мембранозный вырост базального членика хелицеры; or — ротовое отверстие; p — пальпа; p_{1-5} — членики пальпы; ph — глотка; ptr — претрохантеральный мыщелок; protr. c — мышцы-выдвигатели капсулы гнатемы; protr. ch — мышцы-выдвигатели хелицер; retr. c — мышцы-втягиватели капсулы гнатемы; retr. ch — мышцы-втягиватели хелицер; s — сигмоидные склеротизированные вставки — сигмоиды; sch — субхелицеральное пространство; st — стигмы; sph — подглоточный склерит; tr — трахейные стволы; uap — U-образная аподема.