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MORPHOLOGY OF DOLICHOPODIDAE (DIPTERA) WINGS

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[Чурсина М.А., Негробов О.П., Селиванова О.В. Морфология крыльев Dolichopodidae (Diptera)]
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Ключевые слова: *Diptera, Dolichopodidae, крылья, родовые признаки*

Summary. The wings of 23 genera of Dolichopodidae (Diptera) were investigated with the aim to detect quantitative characters suitable for the identification. 15 sections of veins were measured, and 13 coefficients of ratios were obtained. The coefficients were verified for reliability using Student's test. The coefficients showing maximally significant differences are suggested for using to diagnose Dolichopodidae's genera.

Резюме. Для выявления количественных родовых признаков были рассмотрены крылья долихоподид 23 родов. Измерены 15 участков жилок и получены 13 коэффициентов соотношений. Коэффициенты соотношений были проверены на достоверность различий с помощью коэффициента Стьюдента. Соотношения, показавшие максимальное достоверное различие, предлагаются для использования при диагностировании родов семейства Dolichopodidae.

INTRODUCTION

Family Dolichopodidae (Diptera) is one of the most numerous within the Holarctic region, being widespread in various biogeographical areas.

A number of diagnostic keys exists to the family [Aldrich, 1905, Becker, 1921, Stackelberg, 1933, Parent, 1938, Negrobov, Stackelberg, 1969]. The wing venation is pointed out of all authors as an important diagnostic character for the majority of families of flies, for Dolichopodidae family in particular. Still in most cases, used characters are qualitative, for example presence or lack of this or that vein, or degree of its branching [Rodendorf, 1937]. Quantitative characters of morphology of Dolichopodidae wings are still waiting to find their use at identification of taxons of different level [Chursina et al., 2012, Negrobov, Chursina, 2012].

The aim of this work was to identify and compare new diagnostic characters of generic level ih the morphology of Dolichopodidae wings.

MATERIALS AND METHODS

The photos of the wings preparations made on a digital microscope «Pro» Ì100, from the collection of Voronezh State University were used for the analysis. 205 species from 23 genera were studied.

The following species of genus were investigated. *Achalcus* Lw.: *A. cinereus* (Haliday, 1851), *A. flavicollis* (Meigen, 1824); *Argyra* Lw.: *A. argentina* (Meigen, 1824), *A. argiria* (Meigen, 1824), *A. auricollis* (Meigen, 1824), *A. diaphana* (Fabricius, 1775), *A. elongata* (Zetterstedt, 1843), *A. grata* Loew, 1857, *A. leucocephala* (Meigen, 1824), *A. magnicornis* (Zetterstedt, 1838), *A. oreada* Negrobov, 1973, *A. perplexa* Becker, 1918, *A. setimana* Loew, 1859, *A. skufjini* Negrobov, 1965, *A. spoliata* Kowarz, 1879, *A. subartica* Ringdahl, 1920; *Asyndetus* Lw.: *A. albipalpus* Loew, 1871, *A. barbiventris* Stackelberg, 1952, *A. connexus* (Becker, 1902), *A. izius* Negrobov, 1973, *A. latifrons* (Loew, 1857), *A. longicornis* Negrobov, 1973; *Campsicnemus* Wlk.: *C. albilabris* (Zetterstedt, 1859), *C. armatus* (Zetterstedt, 1849), *C. barbitibia* Stackelberg, 1947, *C. compeditus* Loew, 1857, *C. curvipes* (Fallén, 1823), *C. dasycnemus* Loew, 1857, *C. filipes* Loew, 1859, *C. lumbatus* Loew, 1857, *C. magius* (Loew, 1845), *C. marginatus* Loew, 1857, *C. paradoxus* (Wahlberg, 1844), *C. pectinulatus* Loew, 1864, *C. picticornis* (Zetterstedt, 1843), *C. pumilo* (Zetterstedt,1843), *C. pussilus* (Meigen, 1824), *C. scambus* (Fallen, 1823), *C. umbripennis* Loew, 1856, *C. varipes* Loew, 1859; *Chrysotus* Meig.: *C. blepharosceles* Kowarz, 1874, *C. cilipes* Meigen, 1824, *C. cupreus* (Macquart, 1827), *C. femoratus* Zetterstedt, 1843, *C. gramineus* (Fallen, 1823), *C. kowarzi* Lundbeck,1912, *C. laesus* (Wiedemann, 1817), *C. microcerus* Kowarz, 1874, *C. molliculus* (Fallén, 1823), *C. monochaetus* Kowarz, 1874, *C. neglectus* (Wiedemann, 1817), *C. pulchellus* Kowarz, 1874, *C. varians* Kowarz, 1874; *Diaphorus* Macq.: *D. deliquescens* Loew, 1871, *D. disjunctus* Loew 1857, *D. dolichocerus* Stackelberg, 1947, *D. exunguiculatus* Parent, 1925, *D. hoffmannseggi* Meigen, 1830, *D. nigricans* Meigen, 1824, *D. oculatus* (Fallen, 1823), *D. parenti* Stackelberg, 1928, *D. sokolovi* Stackelberg, 1928, *D. winthemi* Meigen, 1824; *Dolichopus* Latr.: *D. acuticornis* Fallen, 1823, *D. albiciliatus* Loew, 1862, *D. amurensis* Stackelberg, 1930, *D. argyrotarsis* Wahlberg, 1850, *D. bianchii* Stackelberg, 1929, *D. ciscaucasicus* Stackelberg, 1927, *D. discifer* Zetterstedt, 1849, *D. eurypterus* Gerstäcker, 1864, *D. excisus* Loew, 1859, *D. galeatus* Loew, 1871, *D. gorodkovi*

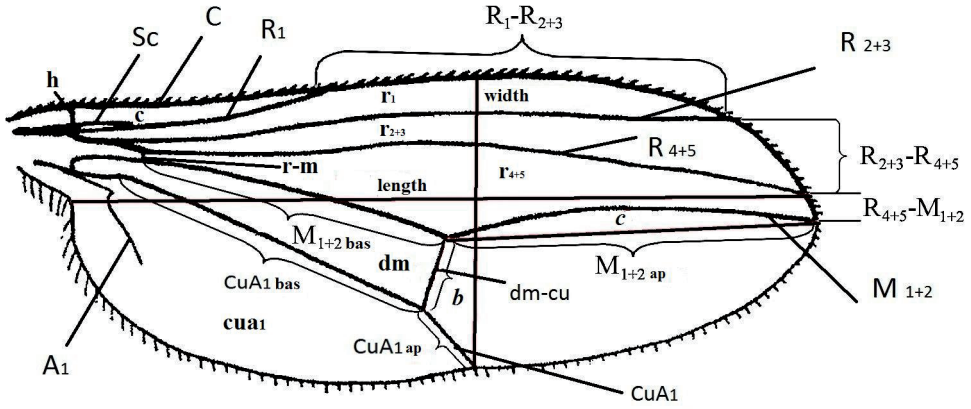

Fig. 1. Sections of veins that were selected for measuring. Veins: C – costa, Sc – subcosta, R_1, R_{2+3}, R_{4+5} – radius, M_{1+2} – media, CuA_1 – anterior branch of cubitus, A_1 – anal. Crossveins: r-m – radial-medial, dm-cu – distal medial-cubital, h – humeral. Cells: c – costal, r_1, r_{2+3}, r_{4+5} – radial, dm – distal medial, cua_1 – anterior cubital

Рис. 1. Участки жилок, выбранные для измерения. Жилки: C – костальная, Sc – субкостальная, R_1, R_{2+3}, R_{4+5} – радиальные, M_{1+2} – медиальная, CuA_1 – кубитальная, A_1 – анальная. Поперечные жилки: r-m – радиально-медиальная, dm-cu – дистальная медиально-кубитальная, h – плечевая. Ячейки: c – костальная, r_1, r_{2+3}, r_{4+5} – радиальные, dm – дистально-медиальная, cua1 – передняя кубитальная

Negrobov, 1973; *Hercostomus* Lw.: *H. apollo* (Loew, 1869), *H. bicolor* Yang et Saigusa, 2001, *H. brevicornis* Zhang, Yang, Grootaert, 2008, *H. caucasicus* Stackelberg, 1933, *H. chetifer* (Walker, 1849), *H. cupreus* (Fallen, 1823), *H. fugax* (Loew, 1857), *H. germanus* (Wiedemann, 1817), *H. longiventris* (Loew, 1857), *H. praeceps* Loew, 1869, *H. rubroviridis* Parent, 1927, *H. sahlbergi* (Zetterstedt, 1838); *Hydrophorus* Flln.: *H. albiceps* Zetterstedt, 1843, *H. alpinus* Wahlberg, 1844, *H. balticus* (Meigen, 1824), *H. bipunctatus* (Lehmann, 1822), *H. bisetus* Loew, 1857, *H. borealis* Loew, 1857, *H. brunnicosus* Loew, 1857, *H. forcipatus* Frey 1915, *H. geminus* Frey, 1915, *H. koznakovi* (Becker, 1917), *H. litoreus* Fallén, 1823, *H. magnicornis* Frey, 1915, *H. micans* Frey, 1915, H. *nebulosus* Fallén, 1823, *H. pectinatus* Gerstäcker, 1864, *H. pilipes* Frey, 1915, *H. praecox* (Lehmann, 1822), *H. rogenhoferi* Mik, 1874, *H. thibetanus* (Negrobov, 1977), *H. viridis* (Meigen, 1824), *H. wahlgreni* Frey, 1915; *Hypophyllus* Halid.: *H. crinipes* (Staeger, 1842), *H. discipes* (Germar, 1821), *H. obscurellus* (Fallen, 1823); *Medetera* Fisch.: *M. abstrusa* Thuneberg, 1955, *M. bilineata* Frey, 1915, *M. brunea* Negrobov, 1970, *M. fascinator* Negrobov, 1972, *M. grunini* Negrobov, 1966, *M. impigra* Collin, 1941, *M. media* Parent, 1925, *M. micacea* Loew, 1857, *M. muralis* Meigen, 1824, *M. nitida* (Macquart, 1834), *M. pallipes* (Zetterstedt, 1843); *Melanostolus* Kow.: *M. melancholicus* (Loew, 1869), *M. nigricilius* (Loew,1871); *Neurogona* Rd.: *N. biflexa* Strobl, 1909, *N. cilipes* (Oldenberg, 1904), *N. longipes* Becker, 1918, *N. pallida* (Fallen, 1823), *N. quadrifasciata* (Fabricius, 1781), *N. suturalis* (Fallén, 1823); *Poecilobothrus* Mik.: *P. bigoti* Mik, 1883, *P. clarus* (Loew, 1871), *P. comitialis* (Kowarz, 1867), *P. fumipennis* (Stannius, 1831), *P. infuscatus* (Stannius, 1831), *P. nobilitatus* (Linnaeus, 1767); *Rhaphium* Meig.: *R. antennatum* (Carlier, 1835), *R. commune* (Meigen, 1824), *R. confine* Zetterstedt, 1843, *R. crassipes* (Meigen, 1824), *R. discigerum* Stenhammar, 1850, *R. discolor* Zetterstedt, 1838, *R. elegantulum* (Meigen, 1824), *R. fascipes* (Meigen, 1824), *R. firsovi* Negrobov, 1976, *R. fractum* Loew, 1850, *R. glaciale* (Ringdahl, 1920), *R. gussakovskii* (Negrobov, 1976), *R. laticorne* (Fallen, 1823), *R. longicornis* Meigen, 1824, *R. micans* (Meigen, 1824), *R. nasutum* (Fallen, 1823), *R. patellitarse* Negrobov, 1979, *R. patulum* (Raddatz, 1873), *R. pectinatum* (Loew, 1859), *R. penicillatum* Loew, 1850, *R. praerosum* Loew, 1850, *R. rivale* (Loew, 1869), *R. suave* (Loew, 1859); *Scellus* Lw.: *S. alactaga* Stackelberg, 1951, S. *bianchii* Stackelberg, 1951, *S. gallicanus* Becker, 1909, *S. hissaricus* Stackelberg, 1951, *S. notatus* (Fabricius, 1781), *S. paramonovi* Stackelberg, 1926, *S. tschernovski* Stackelberg, 1951; *Sciapus* Zllr.: *S. albifrons* (Meigen, 1830), *S. bellus* (Loew, 1873), *S. contristans* (Fallen, 1823), *S. evanidus* (Bezzi, 1898), *S. flavicinctus* (Loew, 1857), *S. laetus* (Meigen, 1838), *S. lobipes* (Meigen, 1824), *S. maritimus* Becker, 1918, *S. wiedemanni* (Fallen, 1823); *Sympicnus* Lw.: *S. aeneicoxa* (Meigen, 1824), *S. annulipes* (Meigen, 1824), *S. brachydactylus* Kowarz, 1889, *S. simplicipes* Becker, 1908; *Syntormon* Lw.: *S. cilitibia* Stackelberg, 1947, *S. freymuthae* Loew, 1873, *S. metathesis* (Loew, 1850), *S. monilis* Parent, 1938, *S. pallipes* (Fabricius, 1794), *S. pumilus* (Meigen, 1824), *S. rufipes* (Meigen, 1824), *S. subinermis* (Loew, 1869), *S. tarsatus* (Fallen, 1823), *S. zelleri* (Loew, 1850); *Systenus* Lw.: *S. bipartitus* (Loew, 1850), *S. pallipes* (von Roser, 1840); *Tachytrechus* Wlk.: T. *ammobates* (Haliday,1851), *T. genualis* Loew, 1857, *T. gussakovskii* Stackelberg, 1941, *T. insignis* (Stannius, 1831), *T. notatus* (Stannius, 1831), *T. ripicola* Loew, 1857; *Teuchophorus* Lw.: *T. monacanthus* Loew, 1859, *T. pectinifer* Kowarz, 1868, *T.*

signatus (Zetterstedt, 1849), *T. spinigerellus* (Zetterstedt,1843); *Thrypticus* Gerst.: *T. bellus* Strobl, 1880, *T. divisus* (Strobl, 1880), *T. laetus* Verrall, 1912, *T. paludicola* Negrobov, 1971, *T. pollinosus* Verrall, 1912.

15 section of veins (see Fig.1) were measured and 13 coefficients of ratios were received. Coefficients of ratios were checked on reliability of distinctions by means of Student's test. Measurements were carried out in the Adobe Illustrator program.

RESULTS AND DISCUSSION

Wings of Dolichopodidae flies are usually oval, approximately equal in length to their body [10]. However there are some generic differences in the ratio of wing length to width. For example, the species of *Campsicnemus* Wlk., *Hydrophorus* Flln. and *Hypophyllus* Halid. have narrower and longer wings., while the species of *Sciapus* Zllr. have rather wide wings. Species of *Diaphorus* Macq. have wings of different shape: narrowing in the apical part.

The membrane of Dolichopodidae wing is usually hyaline but sometimes brownish or grayish, or with brown spots, as in the species of *Hercostemus* Lw., *Poecilobothrus* Mik. Some *Dolichophorus* Lichtw. species have darkened radial cells, in *Scellus* Lw. species wings are mostly darkened, some species of *Condylostylus* Big. (*Condylostylus nigripilosus* Rob.) have two transversal brown spots, conjunct from above. Infrequently wings may bear brown spots in the fore half (*Hydrophorus nebulosus* Fal.) on a bend of apical section of medial vein, and on the distal medial-cubital vein (*Hydrophorus albiceps* Zett.).

The costal vein usually extends to junction with a medial vein (for example, in species of *Diaphorus* Macq.), rarely – reaches R_{4+5} (species of *Asyndetus* Lw.). The subcostal vein comes to an end joining the radial vein R_1 at its beginning, except for the species of Hydrophorinae subfamily, in which the subcostal vein joins to the radial vein in the middle of the last. The costal vein can be strongly thickened at R_1 (species of *Teuchophorus* Lw.) or the thickening is absent (species of *Sympycnus* Lw.). Radial veins (R_1, R_{2+3}, R_{4+5}) begin at level of a cross humeral vein or very close to it.

The radial vein R_{4+5} is not branched out. It should be noted that the ratio of the length of R_{2+3} to the length of R_{4+5} may not be a diagnostic character due to its wide variation. Length ratio of the section of costal vein between the points of joining of R_{2+3} and R_{4+5} to the R_{4+5} length allows to separate two groups of species. The species with rather long distance between the sites of joining of R_{2+3} and R_{4+5} make the first group, they are *Campsicnemus* Wlk., *Chrysotus* Meig., *Hydrophorus* Flln., *Neurogona* Rd., *Poecilobothrus* Mik., *Sciapus* Zllr., *Syntormon* Lw. The species of *Diaphorus* Macq. and *Sympicnus* Lw., having the smallest value of this measurement, form the second group.

The medial vein (M_{1+2}), being straight upto the cross vein dm-cu, is sometimes branched out or bent near the middle of apical part of the wing (species of *Asyndetus* Lw., *Sciapus* Zllr.). The degree of curvature of an apical section of the medial vein may be measured, having carried out a section from its beginning to its end and then having correlated the length of apical segment of the medial vein to the length of this section, but our study did not reveal statistically reliable hiatus in this character values.

The ratio between length of the medial vein basal section and the length of apical section might be useful also. Species of *Scellus* Lw. have the maximum ratio of these measurements. Medial vein M_2 is present in *Sciapus* Zllr. species, but absent in other species, or barely noticeable (*Dolichopus griseipennis* Stann.). The relation in length between the basal and apical sections of this vein also may serve as the specific diagnostic character.

The radial vein R_{4+5} and medial vein M_{1+2} are usually parallel to each other, but they may diverge (species of subfamily Enliniinae) or converge apically (some species of *Hercostemus* Lw.). However we did not manage to reveal statistically reliable generic pattern concerning distance between R_{4+5} and M_{1+2} on the edge of a wing.

Significant taxonomic character is the situation and degree of bend of the cross vein dm-cu. The distal medial-cubital vein can be arcuately bent (*Sciopus nervosus* Lehm.), or bent in the middle of the basal part of wing (species of *Tachytrechus* Wlk.) or straight (species of *Hercostomus* Lw.). The distal medial-cubital vein can have a brown smoky border (*Tachytrechus insignis* Stan.). It could be longer than the CuA_1 apical section length (species of *Hydrophorus* Flln.) or shorter (species of *Campsicnemus* Wlk.).

The cubital vein CuA_1 is divided on basal and apical section by the site of joining of distal medial-cubital vein. The relation between the basal and apical sections lengths of the cubital vein fluctuates over a wide range. For example, species of *Hydrophorus* Flln. and *Scellus* Lw. have the maximum value of this coefficient.

The dm and bm cells are connected. The distal medial-cubital vein is short; in some species it is situated in the apical part of wing (species of *Aphrosylus* Walk.) or approximately in the middle of wing (species of *Poecilobothrus* Mik.), or may be moved to the basal part (species of *Micromorphus* Mik.).

Radial-medial cross vein is in the basal part of wing. The anal vein is sometimes reduced or absent (species of *Achalcus* Lw.).

Summarizing the results, the following ratios may be used in the generic diagnostic of Dolichopodidae, as showing the greatest statistical reliability.

1. Relation of the length of basal section of M_{1+2} to the length of apical section of M_{1+2}. In species of *Asyndetus* Lw. the distal medial-cubital vein is located in the basal part of wing that assumes the smallest value of this relation (0,25±0,6). Species of *Scellus* Lw. and *Sciapus* Zllr. show the maximum value (1,46±0,01 and 1,68±0,29 respectively).

2. Relation of the length of basal section of CuA_1 to the length of apical section of CuA_1. The species of

Asyndetus Lw. have the minimum value of this ratio (0,24±0,08), and the species of *Scellus* Lw. and *Hydrophorus* Flln. have significantly increased values (7,45±0,67 and 7,18±0,62 respectively).

3. Relation of dm-cu length to the length of apical part of CuA_1 is significant for *Scellus* Lw. and *Hydrophorus* Flln. species (1,54±0,15 and 1,48±0,13), and species of *Asyndetus* Lw. (0,13±0,02).

4. Relation of R_{2+3} length to R_1 length allows to separate the species of *Achalcus* Lw. (4,27±0,07) and *Argyra* Lw. (1,87±0,10).

5. The measurement of the distance on the edge of wing between places of R_{2+3} and R_{4+5} joining to the distance between places of R_{4+5} and M_{1+2} joining allows to separate species of *Tachytrechus* Wlk. with the maximum value of this relation (8,97±1,01).

6. The relation of the length of costal vein section between places of R_{2+3} and R_{4+5} confluence to the length of R_{4+5} allows to separate species of *Campsicnemus* Wlk. (0,66±0,02), *Chrysotus* Meig. (0,67±0,05), *Hydrophorus* Flln. (0,60±0,02), *Neurogona* Rd. (0,62±0,04), *Poecilobothrus* Mik. (0,70±0,01), *Sciapus* Zllr. (0,67±0,03), *Syntormon* Lw. (0,70±0,01) as the species having the maximum value of this ratio. *Diaphorus* Macq. (0,13±0,01) and *Sympicnus* Lw. (0,15±0,01) have the smallest value of this character.

7. The relation of wing length to wing width is suitable for separating the species of *Sciapus* Zllr. Wings of these species are wider and shorter than in other genera, the calculated coefficient makes 1,92±0,09. Species of *Campsicnemus* Wlk., *Hydrophorus* Flln. and *Hypophyllus* Halid. have narrower and longer wings (2,57±0,05; 2,75±0,05; 2,59±0,13 respectively).

The given relations can be used for the identification of genera in the Dolichopodidae family. Morphometric characters of wings can be added further with the morphometric characters of the body and various parts of feet of the Dolichopodidae flies.

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