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Immature Stages of the Central European Species of *Colymbetes* CLAIRVILLE (*Coleoptera, Dytiscidae*)

Młodsze postacie rozwojowe środkowoeuropejskich gatunków z rodzaju *Colymbetes* CLAIRVILLE (*Coleoptera, Dytiscidae*)

Ювенальные стадии развития средне-европейских видов из рода *Colymbetes* CLAIRVILLE (*Coleoptera, Dytiscidae*)

[With 57 figures in the text]

The present paper is a second in a series devoted to the immature stages of European *Dytiscidae* which seem to have been very little studied so far. There are three species of *Colymbetes* CLAIRV. occurring in Central Europe — *C. fuscus* (L.), *C. striatus* (L.) and *C. paykulli* ER., but only larvae and pupa of *C. fuscus* (L.) have been hitherto described[1], and these descriptions contain few diagnostic characters which could make the identification possible.

Filling the gap the paper provides the detailed descriptions of larvae of all three species mentioned above, the description of pupae of *C. fuscus* (L.) and *C. striatus* (L.) and a general description of eggs. Keys to the identification of larvae and pupae are also included. The descriptions are based on the reared ex ovo material, as well as on the larvae collected in the field, part of which was reared in the laboratory until the pupal or imaginal stage. The biological observations were made both in the laboratory and in the field. Almost all material has been collected and reared by the author in Poland and is kept in the collection of the Institute of Zoology of the Polish Academy of Sciences in Warsaw.

The research was carried out in the years 1956–1962 at the Coleopterological Laboratory of the mentioned Institute. I wholeheartedly thank all the persons who helped me in this work.

[1] Third stage larva: SCHIÖDTE, 1864 and MEINERT, 1901; all larval stages BERTRAND, 1928; pupa: SCHIÖDTE, 1864 and BERTRAND, 1928.

Unlike in the genus *Rhantus* DEJ. most of diagnostic characters of the larvae are confined to the head.

Shape of Head. This character is of a great importance to the identification of the first and second stage larvae of all three species. In the third stage, due to rather inconspicuous differences, the shape of head rather can not be relied upon.

Length of Maxillar and Labial Palpi. The characters in question are very reliable as far as first two stages are concerned, and are of a great help in the descrimination of larvae of *C. fuscus* (L.) from those of *C. striatus* (L.) and *C. paykulli* ER., the last two species having very similar palpi. The specific differences in the third larval stage are rather small and the diagnosis should be based chiefly on other characters.

Length of Antennae. The length of antennal joints can be of a certain help in separating the larvae of *C. fuscus* (L.) from those of *C. striatus* (L.) and *C. paykulli* ER., but only in the first two stages. The differences, however, are much less conspicuous than those observed in the palpi.

Shape of Mandibles. This character belongs to the most reliable ones, and can be used for the identification of the third stage larva of all three species. In the first and second stage *C. striatus* (L.) and *C. paykulli* ER. do not exhibit any particular difference between each other in this respect.

Number of Temporal Spines. The different number of temporal spines in the second and third stage larva of *C. striatus* (L.) and in those of *C. fuscus* (L.), greatly help to identify the species mentioned. This character is particularly valuable in the third stage where variability seems to be smaller than in the second stage. The number of temporal spines is, unfortunately, not reliable in *C. paykulli* ER., as it may overlap either that in *C. striatus* (L.) or that in *C. fuscus* (L.).

Distinctness of Tentorial Fossettes. This is a very reliable and valuable character which facilitates enormously the identification of the second and third stage larvae of *C. fuscus* (L.) and *C. striatus* (L.).

Punctuation of Upper Side of Head. The density of punctures may be of some help in the identification of the second and third stage larvae of all three species.

Colour of Upper Side of Head. The dark colouring of head and its barely visible colour pattern greatly helps to separate the third stage larvae of *C. paykulli* ER. from those of *C. striatus* (L.) and *C. fuscus* (L.). In the first two stages this character fails and other features, such as shape of head, must be employed for the identification. The vivid „mottled" colouring of the dorsal side of head of the second and third stage larvae of *C. fuscus* (L.) (a distinct pale band is visible in the third stage) may serve as a useful, supplementary character in the determination of the larvae concerned.

Shape of Pronotum. The shape of anterior angles of pronotum has proved to be a useful diagnostic character in the first and second stage,

particularly in the first one. Unfortunately, only two species can be separated, as *C. paykulli* ER. shows no particular difference in this respect with *C. striatus* (L.).

Length of Tarsal Claws. Certain differences in the length of tarsal claws are exhibited only by the second and third stage larvae (in the third stage the differences are the most conspicuous) and may help to separate *C. fuscus* (L.) from *C. striatus* (L.) and *C. paykulli* ER., the last two species having the tarsal claws of similar shape.

Although the identification of the larvae of particular species should not present any special difficulties, certain variability of larval characters must be reckoned with, and the identification, if it is expected to be a correct and accurate one, must always be based on several morphological features, and particularly so when the material is scanty or the other species of the genus are not available for comparison.

So far as separating of *Colymbetes* larvae from those of other genera e. g. *Rhantus* DEJ. is concerned great emphasis is usually laid on the presence of a „tooth" or „bulge" on the inner edge of mandibles (BERTRAND, 1828; BALFOUR-BROWNE, 1950). This character, however, seems to occur only in the second and third stage larvae of *C. fuscus* (L.) [Figs. 28, 29]. There is an extremely slight „bulge" in the third stage larva of *C. striatus* (L.) [Fig. 31] (certainly no more conspicuous than in certain species of *Rhantus* DEJ.), but in *C. paykulli* ER. [Figs. 32, 33] the inner mandibular face is fairly smooth, so this feature can not be used as a generic character. Similarly, the short, broad mandibles, a character also held as a generic one, can only be attributed to the larvae of *C. fuscus* (L.). *C. striatus* (L.) and *C. paykulli* ER. have mandibles definitely more elongate.

Diagnosis of the Genus

Eggs. [Figs. 1–3] Length 1.6–2.0 mm. Whitish colour of newly laid eggs change into grey or brownish-grey after several days. Shape of eggs elongate-oval; it does not show any specific differentiation.

During the hatching of the larva the eggs' shell splits lengthwise, similarly as in the other genera of *Dytiscidae*.

Larvae. Body broad, distinctly broader than in other *Colymbetinae* larvae. Head broad, in last two stages carrying 5–13 temporal spines. Neck broad. Antennae composed of four joints, the apical one equal in length to, or a little shorter than the penultimate. Mandibles moderately curved, about 2–3 times longer than wide at their base. Maxillar palpi consisting of three joints. Labial palpi consisting of two joints. Upper side of head in second and third stage covered by dense and distinct punctures and with a distinct colour pattern. Underside of head in last two stages with distinct, well developed setae. Terga broad in proportion to their length, distinctly punctured in last two stages. Two last abdominal segment fairly long and narrow. Terminal abdominal

segment distinctly conical, with slightly concave lateral walls and without distinct terminal projection in the apical part. Cerci long, narrow, mobile. Basal joint of cerci very short. Cercal setae, except apical ones, not arranged in groups but scattered along sides of cerci. Tarsal claws underneath armed with small setae. Apical part of tibiae and femora of first stage larvae provided with very long, strong setae. Second and third stage larvae with well developed secondary setation. Spines (or setae) on tarsi, tibiae and femora single not bifid.

First Stage Larvae. Body 5.2–9.5 mm long. Dorsal side mainly unicolorous, brown or dark brown. Head with sides diverging anteriorly, usually darker than the rest of body. Apical joint of palpi not shorter than penultimate. Apical joint of antennae about the length of penultimate. Frontal tubercles distinct. Temporal spines not present. Upper side of head either unicolorous or with slight, indistinct, dark marking on paler ground-colour; no punctures visible. Anterior edge of pronotum without incisions at sides, anterior angles therefore not protruding. Anterior edge of meso- and metanotum relatively straight. Terminal abdominal segment sclerotized only on its dorsal side; dorsal side bearing no setae. Cerci carrying only seven primary setae. Legs bearing only few, primary setae; these are exceptionally long and strong in the apical part of femora and tibiae. Tarsal claws long and narrow, distinctly longer than half of tarsus.

Second Stage Larvae. Body 9.5–16.6 mm long. Dorsal side of body with fairly distinct, pale colour pattern, at least in the anterior part. Head parallel-sided or with sides slightly diverging anteriorly. Apical joint of antennae and palpi slightly shorter than the penultimate. Frontal tubercles not visible. Temporal spines present. Upper side of head with numerous pale spots arranged in rows along lateral borders and epicranial suture, and with distinct punctures. Anterior edge of pronotum with slight incisions at sides; anterior angles of pronotum slightly protruding. Anterior edge of meso- and metanotum strongly concave. Terminal abdominal segment sclerotized on dorsal, as well as ventral side, with sparse but distinct setation on dorsal side. Cerci carrying also secondary setae; their total number varies from 19 to 23 on outer face and from 27 to 45 on inner face of cercus. Legs carrying primary as well as secondary setae; the setae in the apical part of femora and tibiae short, spine-like. Tarsal claws shorter than in the first stage; length of hind tarsal claws roughly equaling half of length of tarsus.

Third Stage Larvae. Body 16.6–35.5 mm long. Dorsal side of body with pale, distinct colour pattern. Head with sides strongly converging anteriorly. Apical joint of antennae and palpi shorter than the penultimate. Frontal tubercles not visible. Temporal spines present. Upper side of head with distinct colour pattern consisting of small, numerous, pale spots, arranged in rows in basal half of head and rather separated from one another; punctuation well marked. Anterior edge of pronotum with very distinct lateral incisions;

anterior angles of pronotum strongly protruding. Anterior edge of meso- and metanotum very strongly concave. Terminal abdominal segment sclerotized on its ventral side, covered by numerous setae on dorsal side. Cerci carrying primary and secondary setae; their total number varies from 16 to 26 on outer face and from 30 to 50 on inner face of cercus. Legs provided with primary and secondary setae; all setae short, spine-like. Tarsal claws very short; length of hind tarsal claws smaller than half of tarsal length.

Pupae. Body slender, 15.3–18.4 mm long. Head with distinct cephalic prominences, each of them carrying 11–25 setae. Preocular area bearing 4–6 setae. Anterior border of clypeus fournished with 1–9 setae on each side. Each half of pronotum with 24–55 setae along anterior margin, with 1–5 setae in the middle part, and with 2–7 setae along posterior border (apart from a cluster of setae at posterior angles). Meso- and metanotum carrying each 5–10 setae in the middle part (on each half of tergum) and 1–3 setae in the lateral part. Number of setae on each half of abdominal terga varying from 3 to 11 in the median part and from 1 to 4 in the lateral part. Last abdominal tergum provided with 20–45 setae. Last abdominal sternum bearing 1–2 setae at posterior angles. Gonopods in male specimens with distinctly projected apex, in female specimens broad, more or less rounded. Cerci curved, with well developed setation; number of setae on each cercus varying from 10 to 23.

Key to larvae

1. Cerci with seven setae only. No temporal spines. First stage . . . 3.
—. Cerci with more than seven setae. Temporal spines present [Figs. 28–33] . . . . . 2.
2. Sides of head parallel or diverging anteriorly [Figs. 18–22]. Body length 9.5–16.6 mm, its maximum width 2.4–3.0 mm. Second stage . . . . 5.
—. Sides of head strongly converging anteriorly [Figs. 23–27]. Body length 16.6–35.5 mm, its maximum width 4.9–6.0 mm. Third stage . . . . 7.
3. Head short, almost quadrangular; neck short and wide, about six times as wide as long [Fig. 15]. Palpal joints broad [Fig. 34]. . . . . *C. fuscus* (L.).
—. Head distinctly elongate, triangular; neck long and narrow, at most four times wider than long [Figs. 16, 17]. Palpal joints narrow [Figs. 35, 36] . . . . . 4.
4. Neck broader [Fig. 16] . . . . . *C. striatus* (L.).
—. Neck narrower [Fig. 17] . . . . . *C. paykulli* Er.
5. Palpal joints broader, shorter [Fig. 28]. Tentorial fossettes distinct, well marked [Fig. 19]. Mandibles broader, with distinct „tooth" on their inner face [Fig. 28]. Upper side of head with sparser punctures . . . . . *C. fuscus* (L.).
—. Palpal joints slenderer, more elongate [Figs. 30, 32]. Tentorial fossettes almost invisible [Fig. 21]. Mandibles narrower, without „tooth" on their inner face [Figs. 30, 32]. Upper side of head with more numerous punctures . . . . . 6.

6. Head narrower, its lateral margins less „bulging" at base [Fig. 22]. Colour pattern on upper side of head blurred, barely visible . . . . . *C. paykulli* Er.

—. Head broader, its lateral margins distinctly „bulging" at base [Fig. 20]. Colour pattern of upper side of head more distinct . . *C. striatus* (L.).

7. Mandibles with a distinct „tooth" on their inner face [Fig. 29]. Tentorial fossettes very distinct, dark [Fig. 26]. Palpal joints shorter [Fig. 29]. . . . . *C. fuscus* (L.).

—. Mandibles without „tooth" on their inner face, at most with a very slight „bulge" [Figs. 31, 33]. Tentorial fossettes indistinct, pale, sometimes almost invisible [Fig. 27]. Palpal joints more elongate [Figs. 31, 33] . . 8.

8. Dorsal side of head and body black brown or black. Colour pattern on head barely visible, particularly in the middle part [Fig. 25]. Mandibles narrower with smooth inner face [Fig. 33]. Dorsal side of head with stronger punctation . . . . . *C. paykulli* Er.

—. Dorsal side of head and body brown-yellow or yellow. Colour pattern on head distinct [Fig. 24]. Mandibles broader with a slight „bulge" on their inner face [Fig. 31]. Dorsal side of head with sparser and less distinct punctures . . . . . *C. striatus* (L.).

Key to pupae

Unfortunately, I was able to obtain the pupae of only two species.

1. Cerci narrower at base [Fig. 41]. Last abdominal sternum with at most one seta at posterior angles [Figs. 41, 43]. In male specimens gonopods with narrow, pointed apices [Fig. 41]. In female specimens gonopods distinctly elongated [Fig. 43] . . . . . *C. fuscus* (L.).

—. Cerci broader at base [Fig. 42]. Las abdominal sternum with two setae at posterior angles [Figs. 42, 44], at least at one of them. In male specimens gonopods with broad, obtuse apices [Fig. 42]. In female specimens gonopods distinctly rounded [Fig. 44] . . . . . *C. striatus* (L.).

Colymbetes fuscus (Linnaeus, 1758)

First Stage Larva [Fig. 6]

Dorsal side of body brown-olive or dark brown-olive. Head [Fig. 15] short, broad, slightly quadrangular in shape, with sides feebly diverging anteriorly, or parallel, and with distinctly marked temporal angles. Neck broad and short its width exceeding length six times. Colour of upper side of head of a full grown larva dark brown, usually without any pattern. Antennae and palpi [Fig. 34] with short, broad joints. Mandibles [Fig. 34] short, fairly well curved. Colour of appendages yellow, apical part of antennal and palpal joints darkened, brown or dark brown. Pronotum [Fig. 37] fairly narrow and long with distinctly rounded anterior angles. Cerci usually twice the length of last abdominal segment.

The larva can be easily recognized by its short, broad head and neck, its short, broad palpal joints, its short, well curved mandibles, and by its distinctly rounded anterior angles of pronotum.

Second Stage Larva [Fig. 9]

Dorsal side of body usually fairly pale, yellowish-olive or light brown-olive, rarely dark brown-olive; colour pattern not distinct, blurred completely on abdominal terga. Head [Fig. 18] with sides slightly converging anteriorly. Neck fairly broad and short. Antennae and palpi [Fig. 28] with short, broad joints. Mandibles [Fig. 28] short, broad, with a distinct „tooth" on their inner face. Temporal spines sparse, 7–9 in number. Upper side of head yellowish-olive or brown-olive with a distinct colour pattern; pale spots relatively large, some of them distinctly confluent; lateral borders and ocular areas noticeably pale, much paler than ground-colour. Antennae and palpi yellowish or light brown, apical part of their joints distinctly darkened. Punctures on upper side of head rather sparse, concentrated in a regular row across the middle. Tentorial fossettes [Fig. 19] distinct, strongly pigmented, connected by dark streaks with posterior margin of head. Pronotum [Fig. 39] with anterior angles feebly protruding, their apex little rounded. Two last abdominal segments carrying short but strong, thick setae on their dorsal side. Cerci bearing 19–28 setae on their outer face and 27–45 setae on their inner face. Legs with fairly long tarsal claws [Figs. 46–48].

The identification of the larva does not present any difficulties due to its short, „toothed" mandibles, short, broad palpal joints, distinct, strongly pigmented tentorial fossettes on the underside of head, and its usually sparse temporal spines.

Third Stage Larva [Fig. 12]

Dorsal side of body olive-brown or dark olive-brown with fairly distinct colour pattern. Head [Fig. 23] broad with broad and short neck. Palpal and antennal joints [Fig. 29] short. Mandibles [Fig. 29] broad at base with a distinct „tooth" on their inner face. Temporal spines not numerous, their number varying from 7 to 9. Underside with well marked, well pigmented tentorial fossettes [Fig. 26]. Colour of upper side of head brown-olive or dark brown-olive, sometimes with a reddish shade. Underside usually slightly paler than upper side. Colour pattern on upper side of head well marked, distinct; pale spots fairly large, some of them confluent; usually, a distinct pale, arched band visible across the whole width of head [Fig. 23]. Punctures on upper surface of head distinct, well marked, but rather sparse; pale band along clypeal suture almost completely devoid of larger punctures. Underside with strong, well developed, but also rather scarce setae. Apical part of joints of antennae and

palpi distinctly darkened. Mandibles in the apical part strongly darkened, sometimes almost black. Thoracic and abdominal terga distinctly punctured. Two last abdominal segments (except for the apex of terminal one) densely covered by setae; setae strong, well developed. Cerci with 16–26 setae along their outer face, and with 30–50 setae along inner face. Legs with long, well developed tarsal claws [Figs. 52–54].

The larva is easily separated from those of other species because of presence of „tooth" on the inne face of mandibles, the sparse temporal spines, dark, well pigmented tentorial fossettes, and short palpal joints.

Pupa

Body 15.3–16.7 mm long. Cephalic prominences provided with 11–25 setae (each). Postocular area with 4–5 setae. Anterior border of clypeus carrying 1–6 setae. Each half of pronotum bearing 24–44 (most frequently 30–40) setae along anterior border, 1–4 setae in the median part, and 3–7 setae (apart from those grouped at posterior angles) along posterior margin. Meso- and metanotum carrying 5–8 median setae on each side. Abdominal terga I–VIII provided with 3–11 median setae on each side. Last abdominal tergum with relatively scarce setae; they number varying from 20 to 28. Last abdominal sternum usually carrying only 1 seta at posterior angles [Figs. 41, 43]; one side may be sometimes completely devoid of setae. Gonopods in male specimens [Fig. 41] long, narrow, with narrow, pointed apices. Gonopods in female specimens [Fig. 43] distinctly elongated, with blunt, obtuse apices. Cerci [Fig. 41] narrow at base, each cercus carrying 14–19 setae.

Material

About 40 first stage larvae (partly exuviae), 16 second stage larvae, and 5 third stage larvae, obtained ex ovo. 7 first stage larvae, 21 second stage larvae, and over 150 third stage larvae, collected in the field. 5 pupae obtained ex larvae.

Collecting and Rearing Data

1 ♀ taken in Wawrzyszew-Chomiczówka (Warszawa) in a meadow puddle overgrown by *Carex* L., April 28, 1957; 41 eggs laid on April 29–May 8, 1957; about 30 first stage larvae — May 7–13, 1957; 13 second stage larvae — May 13–18, 1957; 3 third stage larvae — May 19–21, 1957; 2 full grown — May 27, 1957. 1 ♀ taken in Warszawa-Buraków (Kampinos Forest) in a puddle overgrown by *Carex* L. and grasses; several eggs laid on May 2, 1957; 7 first stage larvae — May 7, 1957. 1 ♀ taken in Pruszków near Warszawa in a meadow ditch (*Carex* L., grasses, bog plants), April 23, 1959; 12 eggs laid on April 24–25, 1959; 4 first stage larvae — April 26–29, 1959; 3 second stage larvae — May 3, 1959; 3 third stage larvae — May 7, 1959; 2 full grown ones transferred onto sand on May 17, 1959; 1 pupa — Juni 5, 1959.

Wawrzyszew-Chomiczówka (Warszawa) in shallow ephemeral swamps and puddles on a meadow (*Carex* L., grasses): April 3, 1957, 5 first 6 second and 1 third stage larvae,

1 second stage larva reared, moulting on April 7, 1957; April 6, 1957, 1 second stage larva; April 24, 1954, 1 third stage larva; April 24, 1957, about 30 third stage larvae; April 27, 1957, over 100 third stage larvae; May 7, 1957, 2 third stage larvae. Pruszków near Warszawa: April 21, 1959, water-filled ditches on a meadow (shrubs, small trees at margins, *Carex* L., *Iris* L., grasses, algae, bottom slimy with rotting leaves), 5 third stage larvae; April 23, 1959, water-filled ditch on a meadow (*Carex* L. at margins, bottom slimy, fallen *Alnus* leaves, humuses), 11 second stage, and about 30 third stage larvae. Nowa Wieś distr. Warszawa, April 29, 1959, ditches along margin of a pine forest (*Carex* L., *Phragmites* ADANS., grasses, *Alnus* leaves and pine needles on the bottom), 1 first stage larva and 5 third stage larvae, leg. Sz. NOWAKOWSKI. Grodzisk near Warszawa: April 30, 1959, water-filled ditches in an *Alnus* grove (*Carex* L., grasses, *Iris* L., rotting leaves, humuses), 9 third stage larvae; 3 larvae reared in water until May 7, 1959, then transferred onto sand; 3 pupae — May 20, 1959; 1 imago — May 30, 1959; puddles and shallow swamps in an *Alnus* grove (rotting leaves on the bottom), 4 third stage larvae, reared in water until May 7, 1959, then transferred onto sand; 3 pupae — May 20, 1959. Zaborów distr. Warszawa: May 5, 1956, a ditch along the road (grasses, bog plants, rotting leaves on the bottom), 1 third stage larva, reared in water until May 10, 1956 then transferred onto sand; imago — Juni 3, 1956; a shallow, ephemeral pool (overflowed meadow) along forest edge, overgrown by grasses, 5 second stage larvae; May 7, 1954, 1 first, and 6 third stage larvae. Struga near Warszawa, May 20, 1956, a ditch along the road (grasses, some bog plants), 1 third stage larva reared until May 21, 1956, then transferred onto sand; imago — Juni 10, 1956. Hungary, Bócsa ad Kecskémét: May 19, 1958, a large, shallow, ephemeral pool (overflowed pond) on a steppe-like pasture (bottom slimy overgrown by algae, saline water), sparse grasses, 1 third stage larva (dead).

Colymbetes striatus (LINNAEUS, 1758)

First Stage Larva [Fig. 7]

Dorsal side of body usually paler than in *C. fuscus* (L.), brown-olive. Shape of head [Fig. 16] distinctly triangular; lateral margins strongly diverging anteriorly. Neck longer and narrower than in the preceding species, its width exceeding length only four times. Antennal and palpal joints [Fig. 35] narrower, more elongate. Mandibles [Fig. 35] more elongate, less strongly curved. Colour of upper side of head considerably paler, light brown, often with pale patches in the anterior part (specimens may happen with one large, yellow semicircular patch along the anterior margin of head). Pronotum [Fig. 38] with less rounded, well marked anterior angles. Cerci usually a little longer than in *C. fuscus* (L.). Other characters similar as in the preceding species.

The larva can be at once distinguished by its broadly triangular head and a fairly narrow neck. From *C. fuscus* (L.) it may also be easily separated by its slender joints of palpi and antennae.

Second Stage Larva [Fig. 10]

Dorsal side of body usually slightly darker than in the preceding species with colour pattern less distinct. Sides of head [Fig. 20] parallel or almost parallel. Neck narrower, longer in proportion to its width than in *C. fuscus*

(L.). Palpi and (in lesser degree) antennae [Fig. 30] with considerably slenderer, narrower joints. Mandibles [Fig. 30] longer, narrower, with relatively straight inner edge, without „tooth". Temporal spines more numerous, 9–13 (usually 10–11] in number. Punctures on upper side of head more numerous but less distinct, usually irregularly strewn. Upper side usually darker, with less distinct, often blurred colour pattern; spots, if visible, more isolated, and often more numerous; pale patches near eyes and along lateral margins less distinct. Tentorial fossettes [Fig. 21] indistinct, sometimes scarcely visible; streaks between fossettes and posterior margin of head, pale, blurred. Antennae and palpi usually paler than in the preceding species, with joints unicolorous or only very slightly darkened in apical part. Anterior margin of pronotum [Fig. 40] only very slightly incised at sides; anterior angles less strongly protruding than in *C. fuscus* (L.), with less rounded, more pointed apex. Two last abdominal segments with finer, less distinct setation. Cerci paler, bearing finer, more delicate setae. Legs with slightly longer tarsal claws [Figs. 49–51]. Other characters in general similar as in the preceding species.

The larva can be identified by its shape of head and neck, different from that in two other species. The „slenderness" of palpal joints, the smooth inner face of mandibles, very slight pigmentation of tentorial fossettes, and the fair number of temporal spines distinguish the larva from that of *C. fuscus* (L.

Third Stage Larva [Fig. 13]

Dorsal side of body usually slightly darker and with less distinct colour pattern, than in *C. fuscus* (L.). Head [Fig. 24] with usually narrower neck than in *C. fuscus* (L.). Palpi [Fig. 31] with more elongate joints. Mandibles [Fig. 31] narrower at base, with only very slight „bulge" on their inner face. Temporal spines numerous, 10–13 in number; spine-bearing edge longer than in *C. fuscus* (L.), particularly in proportion to length of lateral margin of neck. Colour pattern on dorsal side of head [Fig. 24] less visible than in the preceding species; pale spots smaller, more isolated, less distinct; pale patches near eyes and along lateral margins less distinct, sometimes completely blurred. Underside with more numerous, but thinner, finer setae. Tentorial fossettes [Fig. 27] indistinct, feebly pigmented. Punctures on dorsal side of head less distinct but more numerous than in *C. fuscus* (L.); band along clypeal suture distinctly sprinkled with punctures. Antennae and palpi paler, apical part of their joints considerably less darkened. Mandibles less darkened in apical part. Thoracic and abdominal terga with puncturation less distinct than in the preceding species. Two last abdominal segments with relatively finer setae. Legs with shorter tarsal claws [Figs. 55–57]. Other characters similar as in the forgoing species.

The larva of *C. striatus* (L.) may be easily distinguished from that of *C. fuscus* (L.) by the absence of „tooth" on its mandibles, by its indistinct ten-

torial fossettes, numerous temporal spines, and by more elongate palpal joints. From larva of *C. paykulli* Er. separated by the much paler colouring of the dorsal side of body, and the presence of a slight „bulge" on the oinner face of mandibles.

Pupa [Figs. 4, 5]

Body 17.1–18.4 mm long. Cephalic prominences with 11–15 setae. Preocular area with 4–6 setae. Anterior margin of clypeus with 4–9 setae. Each half of pronotum carrying 30–55 setae along anterior margin (usual number of setae 40–50), 2–5 setae in the middle part, and 2–5 setae along posterior margin (in addition to the „tufts" of setae at posterior angles). Meso- and metanotum carrying 5–10 setae in their middle part (on each side). Number of setae in the median part of I–VIII abdominal terga similar as in the preceding species (3–11; the usual number is 5–8). Last abdominal tergum with more numerous setae than in *C. fuscus* (L.); their number varying from 34 to 45 on each half of tergum; last abdominal sternum bearing 2 setae at posterior angles [Figs. 42, 44]. Gonopods in male specimens [Fig. 42] shorter than in the preceding species, with broad, obtuse, almost square apices. Gonopods in female specimens [Fig. 44] broad, distinctly rounded. Cerci [Fig. 42] distinctly broader at base than in *C. fuscus* (L.), but in general with similar number of setae (14–23); setae in general thicker than in *C. fuscus* (L.), frequently passing to under- and upper side of cerci.

Material

About 20 first stage larvae, (including exuviae), obtained ex ovo. 12 first stage larvae, 30 second stage larvae, and over 150 third stage larvae collected in the field. 7 pupae obtained ex larvae.

Collecting and Rearing Data

1 ♀ taken in Wawrzyszew-Chomiczówka (Warszawa), April 3, 1957, in a shallow meadow swamp overgrown by *Carex* L.; 11 eggs laid on April 4, 1957; 2 first stage larvae — April 9, 1957; 15 eggs laid on April 5, 1957; 1 first stage larva — April 9, 1957, 11 first stage larvae — April 10, 1957; 13 eggs laid on April 6–7, 1957; 9 first stage larvae — April 11–13, 1957; 1 ♀ taken as above; several eggs laid on April 6, 1957.

Wawrzyszew-Chomiczówka (Warszawa) in shallow swamps and puddles on a meadow (*Carex* L., grasses): April 3, 1957, 10 first stage larvae; reared in laboratory 3 larvae moult on April 4, 1957; same date 9 second stage larvae, reared in laboratory 3 of them moult on 6 and 7 April, 1957; April 6, 1957, 2 second, and 2 third stage larvae; April 27, 1957, over 150 third stage larvae; May 7, 1956, 9 third stage larvae, 1 larva reared in laboratory and transferred onto sand on May 10, 1956; imago — May 2–3, 1956; May 18, 1956, 1 third stage larva, reared in laboratory and transferred onto sand on May 18, 1956; pupa — May 7–8, 1956. Pruszków near Warszawa: April 21, 1959, in a meadow ditch (*Carex* L., *Iris* L., grasses on edges, bottom slimy) 5 second, and 2 third stage larvae; April 23, 1959, a meadow

ditch strongly overgrown by *Carex* L. and grasses (humuses, rotting *Alnus* leaves on the bottom), 9 second, and 3 third stage larvae. Nowa Wieś distr. Warszawa, April 29, 1959, ditches along margin of a pine forest (bottom with rotting *Alnus* leaves and pine needles, *Carex* L., *Phragmites* Adans., some grasses), 4 second, and 3 third stage larvae, leg. Sz. Nowakowski. Grodzisk near Warszawa: April 30, 1959, water-filled ditches in a *Alnus* grove (rotting leaves, humuses, *Carex* L., *Iris* L., grasses), 2 third stage larvae; swamps in an *Alnus* grove, 1 third stage larva, reared and transferred onto sand on May 7, 1959; pupa — May 30, 1959. Zaborów near Warszawa (Kampinos Forest), May 7, 1956, water-filled ditches along forest margin (humuses, rotting leaves, *Carex* L., bog plants), 7 third stage larvae, reared in laboratory until May 15, 1959, then transferred onto sand; 3 imagines — June 3, 1956; 1 larva reared until May 10, 1956; 1 pupa — June 3, 1956; May 17, 1959, shallow, ephemeral pool (overflowed meadow) at forest edge, overgrown by grasses, 7 third stage larvae. Warszawa-Łomianki: May 15, 1956, a shallow meadow puddle overgrown by *Carex* L. and grasses, 2 third stage larvae; 1 larva reared in laboratory and transferred onto sand on May 16, 1956; imago — May 27–June 3, 1956; a meadow pool (grasses and bog plants), 3 third stage larvae. Struga near Warszawa: May 12, 1956, an overflowed meadow (water shallow, temporary), 1 third stage larva (leg. M. Jahilnicka), reared in laboratory and transferred onto sand on May 13, 1956; pupa — May 3, 1956; a water-filled ditch along the road, overgrown by grasses and bog plants, 3 third stage larvae; May 20, 1956, 5 third stage larvae, reared in laboratory until May 21, 1956, then transferred onto sand; 4 pupae — May 27–Juni 3, 1956; 2 imagines — Juni 8–9, 1956; 1 imago — Juni 10–12, 1956. Mikołajki distr. Mrągowo: April 14, 1957, small pond overgrown by bog and aquatic plants (*Salix* L. on shores), 1 first stage larva; April 15, 1957, a field pool, no paludal or aquatic vegetation, bottom covered by sod, 1 first, 1 second, and 3 third stage larvae; May 10, 1960, a large field pool overgrown by tufts of *Carex* L., 1 third stage larva; a field pool connected with drains, overgrown by aquatic and bog plants: May 8, 1956, 1 second stage larva; May 23, 1956, 2 third stage larvae; May 10, 1960, 1 second stage larva; leg. E. Gajownik. U.S.S.R, Staraja Derewnia, distr. Leningrad, May 21, 1958, puddles and swamps in tundra, 10 second stage larvae, leg. R. Bielawski.

Colymbetes paykulli Erichson, 1837

First Stage Larva [Fig. 8]

Very similar to the corresponding larva of *C. striatus* (L.), differing only by a slightly narrower head, a narrower neck [Fig. 17] and by slightly slenderer palpal joints.

Second Stage Larva [Fig. 11]

Very similar the the larva of the preceding species, differs from it by a longer and narrower head [Fig. 22] with sides distinctly divergingg anteriorly, less distinct, almost blurred colour pattern on the dorsal side of head, a narrower neck, more distinct punctation on the dorsal side of head, slightly slenderer palpal joints and a greater variability in number of temporal spines (7–12). Colour of dorsal side of body dark red-brown.

Third Stage Larva [Fig. 14]

Dorsal side of body much darker than in two preceding species, black-brown or black. Head [Fig. 25] slightly narrower and longer than in *C. stria-*

tus (L.). Palpal joints slightly slenderer than in the species mentioned [Fig. 33]. Mandibles narrower with inner edge almost straight in the middle, without even a slight „bulge"; the whole inner face presenting a fairly regular curve. Number of temporal spines very variable (5–12). Upper side of head black or brownish-black, underside dark brown. Colour pattern barely distinct, if at all, particularly in the middle of head. Punctation of upper side of head stronger, more distinct. Chaetotaxy of the underside and tentorial fossettes similar as in *C. striatus* (L.).

Due to great morphological similarity, it is much more difficult to separate the larva of *C. paykulli* ER. from that of *C. striatus* (L.), than to separate either of two from the larva of *C. fuscus* (L.). The colouring of dorsal side of head and body and the shape of mandibles seem, hovever, to be good characters in recognizing the species. A certain help may also be the punctation of dorsal side of head.

Material

1 first stage larva, 3 second stage larvae and 15 third stage larvae collected in the field.

I have not, unfortunately, succeded in obtaining the pupa.

Collecting and Rearing Data

1 ♀ taken in Białowieża Forest (National Park), May 8, 1959, in a ditch along the road (*Sphagnum* EHRH., rotting leaves on the bottom); reared in laboratory from May 10, 1959 on; about a dozen eggs (probably not fertilized) laid May 11, 1959. Wawrzyszew-Chomiczówka (Warszawa): April 3, 1957, in a meadow shallow swamp (*Carex* L., grasses), 1 second stage larva; the larva moults on April 6, 1957; May 7, 1957, 8 third stage larvae. Pruszków near Warszawa, April 21, 1959, ditches on a meadow (along margins *Carex* L., *Iris* L., bottom slimy), 2 second stage larvae. Nowa Wieś distr. Warszawa, April 29, 1959, water-filled ditches along forest edge (*Carex* L., grasses, rotting *Alnus* leaves and pine needles on the bottom), 1 full grown third stage larva, leg. Sz. NOWAKOWSKI. Zaborów distr. Warszawa, May 5, 1956, an overflowed meadow (forest edge, grasses, water shallow, temporary). 4 third stage larvae. Warszawa-Łomianki, May 15, 1956, shallow puddles and swamps on a pasture (*Carex* L., aquatic and bog plants, grasses), 2 third stage larvae. Mikołajki distr. Mrągowo, April 4, 1957, small field pond overgrown with paludal and aquatic plants, shrubs at margins, 1 first stage larva.

Habitat

The larvae of *Colymbetes* CLAIRV. are to be found in the same habitats as the adults: small, shallow, temporary water-bodies overgrown by the bog and aquatic plants. Puddles, pools, formed after rain-fall or melting of snow, water-filled ditches, holes, drains etc, are their favoured dwelling sites, and often hundrets of larvae, sometimes of two or three species, may be found in one small water-body. They show no special preference to any particular situation, and may be collected in the open areas, such as meadows or pastures, as well as in the woods or groves. However, they seem to avoid the peaty,

turfy grounds and acid waters overgrown by *Sphagnum* EHRH. So far as my experience goes I was not able to state any particular inclination of any species toward a definite type of small water-body.

Development Cycle

The eggs are laid on the surface of submerged parts (leaves, stalks) of water or bog plants, similarly as in the genus *Rhantus* DEJ. The short, soft ovipositor is not capable to pierce the plant tissues and the only way of laying the eggs seems to be their deposition on the surface of plants, which has also been confirmed by my laboratory observations and those of other authors (WESENBERG-LUND, 1912; BALFOUR-BROWNE, 1950). Whether the species may lay their eggs on the muddy bottom, or otherwise deposit them on any submerged objects (stones, twigs etc.) depends probably on the absence of suitable vegetation. L. W. GRENSLED in its note published in 1946 gave some observations concerning the oviposition of a *Colymbetes* species on the muddy, detritus covered bottom of a drain. The author reports seeing a female which dropped in the drain (without water) and being on the bottom extended its abdomen a number of times, moving from one spot to another and repeating the process. It then retired to the side of the drain. As the author puts it „it had all the appearance of being engaged in ovipositing", but, unfortunately, the author was not able to search for the eggs as the place was inaccesible. As many Dytiscids, however, develop well on the damp cotton wool (BALFOUR-BROWNE, 1950) it may be assumed that a damp mud may satisfactory. In my laboratory the eggs were laid on narrow leaves of *Saggitaria subulata* L., including also the withered ones, and on the leaves and stalks of *Elodea densa* CASP. On the leaves of *Saggitaria* L. the eggs were deposited regularly in a long row along the middle of the leaf. On *Elodea* RICH. where the leaves are considerably shorter the eggs were often strewn irregularly, and they also covered stalks af the plant mentioned. WESENBERG-LUND (1912) records similar observations with regard to eggs laid on *Carex* L. and *Typha* L. The eggs on the long, narrow leaves of *Carex* L., and particularly on the smaller and divided ones, were arranged in a row, often 20 on one leaf, and looked as the author describes it „like a string of pearls". Those deposited on *Typha* leaves, which are much larger and broader, were not so regularly arranged. The number of eggs laid by one female is difficult to establish as the females captured might have already begun the oviposition. According to BLUNCK (1913) *C. fuscus* (L.) lays up to 1000 eggs. In my laboratory the number of eggs laid varied from 7 to 41. The oviposition period lasted in laboratory from 1 to 10 days, and the eggs were laid in short intervals.

The early and mid-spring seems to be the period of oviposition in Poland and probably in Central Europe. I never obtained the eggs in my laboratory, neither did WESENBERG-LUND (1912) observed them in the field, later than May. BERTRAND (1928), however, reports having obtained the larvae ex ovo

in autumn, winter and spring, and collecting the larvae in the field throughout the year. This would indicate that probably in France the oviposition period is extended over the summer, autumn and winter. BERTRAND's data seem to agree partly with those of MEINERT (1901) who mentiones collecting the larvae of *C. fuscus* (L.) at the end of January, and with S. JENSEN (SCHLICK, 1894) records of finding the larvae of this species at the end of February. BALFOUR-BROWNE (1950) reports having found the larvae of *C. fuscus* (L.) from March until June, and presumes that the oviposition may commence in the autumn or winter and continue in the spring. I have obtained the eggs, and collected the larvae at different stages, in April and in the first half of May. WESENBERG-LUND (1912) observed the eggs of *C. fuscus* (L.) in the field in the same period.

The incubation period lasted in my laboratory 3–8 days. The first stage larvae begun to take the food within several hours of the hatching, after having fully distended their contracted body. The larvae are very agile, but, having their legs devoid of swimming hairs, they swimm rather clumsily and mainly crawl on the bottom of the aquarium or on the surface of submerged plants. The food of larvules consisted mainly of small planktonian *Crustacea* (*Cladocera*, *Copepoda*), although they would also catch the small specimens of *Oligochaeta*, Tendipedids larvae or *Culicidae*. The food of larger larvae of second, and particularly of third stage, seems to consist mainly of larvae and pupae of *Culicidae*. The water-bodies where I collected *Colymbetes* larvae were aways strongly populated by the larvae and pupae of *Culicidae*, and I observed often as they were attacked and captured; several *Colymbetes* larvae taken held *Culex* larvae in their mandibles. It is interesting that the development period of *Colymbetes* larvae coincides perfectly with that of *Culicidae*, and the former leave the water bodies as soon as the latter complete their metamorphosis. In my laboratory, apart from *Culicidae*, I also fed the larvae with larvae of *Trichoptera*, *Tendipedidae* and *Oligochaeta* (*Tubifex* HERIC.). My observations concerning the food agree with those of other authors. WESENBERG-LUND (1912) reports feeding the first stage larvae with *Cladocera* and *Ostracoda*, and those of two last stages with *Culex* larvae, which, as the author observed, occurred abundantly in the water-bodies inhabited by *Colymbetes* larvae.

The first moulting took place in the laboratory within 4–7 days of the hatching, and the second one occured roughly after similar period of time. The third stage was longer; the larvae spent in water 7–10 days, after which, fully grown, they were transferred onto damp sand or soil for pupation. Naturally, the larvae which emerge in winter undergo a considerably longer development. MEINERT (1901) collected the larvae at the end of January and S. JENSEN (SCHLICK, 1894) at the end of February which all produced the imagines in May, and this may indicate that in the winter conditions it may take 2–3 months for the larva to complete its metamorphosis.

In the laboratory the larvae pupated in jars filled with damp sand or soil, and the pupal chamber was build 3–5 cm under the surface. The preparation

period during which the larva builds its pupal cell and waits inside for pupation, lasted from one to three weeks. It depends undoubtedly on the temperature and other factors. The pupal stage lasted 7–10 days. In the field the pupation takes place probably fairly far from the water's edge, as the *Colymbetes* larvae are good crawlers and perhaps wander fair distances to find a suitable site. Unfortunately, I have not succeded in finding the pupae in the field, and SCHLICK (1899) which found a great number of larvae of *C. fuscus* (L.) on May 24, 1897, burried under the moss (part of them pupated on May 29, 1897) gives no details about the distance between the place of pupation and the neighbouring water.

The reproduction period of *Colymbetes* CLAIRV. seems always to precede that of *Rhantus* DEJ. While the species of *Colymbetes* CLAIRV. lay their eggs mainly at the end of March and in the beginning of April (at least so far as this country is concerned), and those produce larvae in April and in the beginning of May, the species of *Rhantus* DEJ. oviposit distinctly later, at the end of April and in May, and their larvae appear in May (usually in the second half) and in June. I have never found in Poland any single larva of *Colymbetes* CLAIRV. together with that of *Rhantus* DEJ. but always the former were captured much earlier. This is perhaps due to the biological competition of these two closely related genera, or may result from the succesion of organisms which make up the larvae diet (e. g. *Culicidae* may be replaced later by certain species of *Tendipedidae*).

The breeding of imagines and rearing of larvae are in the main similar as those of *Rhantus* DEJ. The vessels in which the imagines or larvae are kept, must be, of course, larger, and the water deeper (5–7 cm). Similarly, the vessels for pupation should be more spacious; 0.5 l. jars may well serve the purpose. The food for the third stage larvae may contain larger insect larvae; even the full grown larvae of *Trichoptera* (pulled out of their cases) and the larvae of *Ephemeroptera* may constitute a very good catch.

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STRESZCZENIE

Niniejsza praca stanowi monograficzne opracowanie młodszych postaci rozwojowych środkowoeuropejskich gatunków z rodzaju *Colymbetes* Clairv., a mianowicie: *C. fuscus* (L.), *C. striatus* (L.) i *C. paykulli* Er. W części morfologicznej pracy autor podaje ogólną charakterystykę jaj, opisy wszystkich stadiów larwalnych wymienionych wyżej gatunków, jak również opisy poczwarek *C. fuscus* (L.) i *C. striatus* (L.). W pracy podane zostały również klucze do oznaczania larw i poczwarek. Część biologiczna pracy zawiera charakterystykę ekologiczną gatunków oraz omówienie ich cyklu rozwojowego.

РЕЗЮМЕ

Работа является монографическим описанием ювенальных стадий развития средне-европейских видов из рода *Colymbetes* Clairville, т. е. *C. fuscus* (L.), *C. striatus* (L.) и *C. paykulli* Er., причем рассматриваются яйца, все личиночные стадии упомянутых видов, а также куколки *C. fuscus* (L.) и *C. striatus* (L.). В работу включен определитель личинок и куколок. Приводится тоже экологическая характеристика названных видов и циклы их развития.

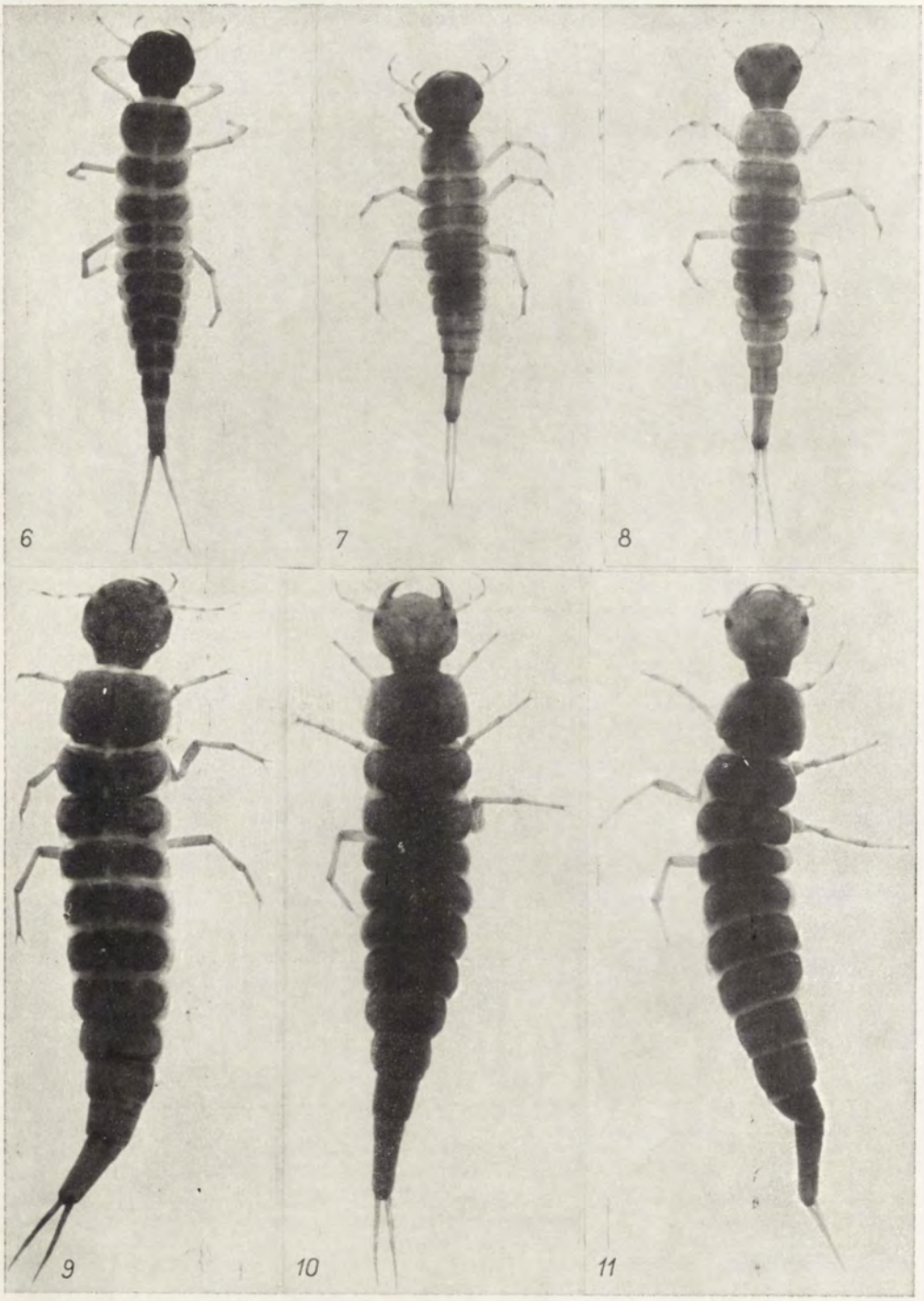
Figs. 1–5.

1–3. *Colymbetes fuscus* (L.), eggs. 1 — eggs on a leaf of *Elodea densa* L., 2 — egg shells on a leaf of *Sagittaria subulata* (L.), 3 — eggs on a stalk of *S. subulata* (L.). 4–5. *Colymbetes striatus* (L.), pupae. 4 — dorsal view, 5 — lateral view.

T. Płodowski phot.

Figs. 6–11. Larvae

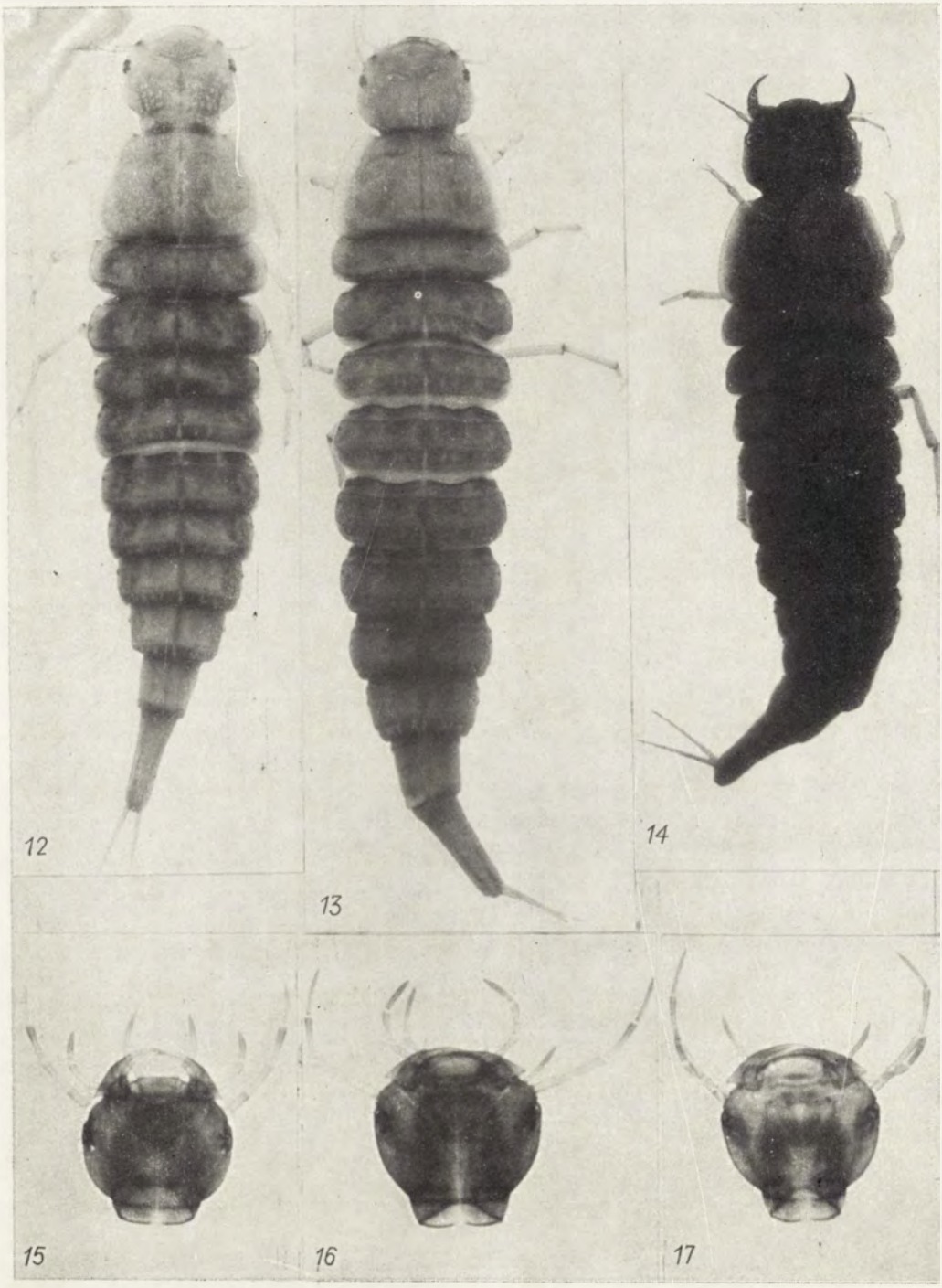
6–8. First stage, 9–11. second stage. 6, 9 — *Colymbetes fuscus* (L.), 7, 10 — *C. striatus* (L.), 8, 11 — *C. paykulli* Er.



T. Plodowski phot.

Figs. 12-17. Larvae

12-14. Third Stage, 15-17. Heads (first stage). 12, 15 — *Colymbetes fuscus* (L.), 13, 16 — *C. striatus* (L.), 14, 17 — *C. paykulli* Er.



T. Płodowski phot.

Figs. 18–22. Heads of larvae of second stage

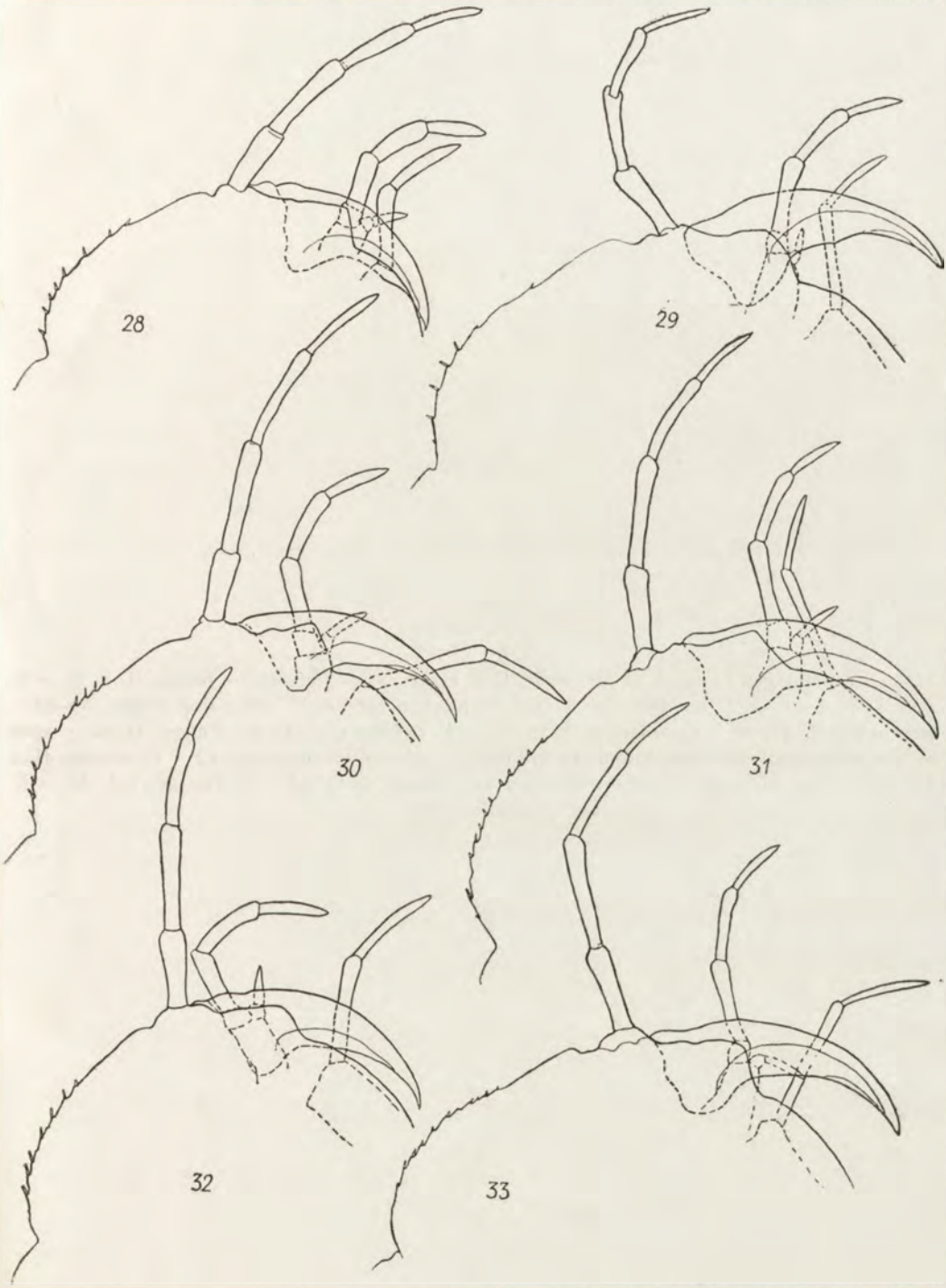
18, 19 – *Colymbetes fuscus* (L.), 18 – dorsal view, 19 – ventral view. 20, 21 – *C. striatus* (L.), 20 – dorsal view, 21 – ventral view. 22 – *C. paykulli* Er., dorsal view.

T. Plodowski phot.

Figs. 23-27. Heads of larvae of third stage
23-25 — dorsal view, 26, 27 — ventral view. 23, 26 — *Colymbetes fuscus* (L.), 24, 27 — *C striatus* (L.), 25 — *C. paykulli* Er.

T. Płodowski phot.

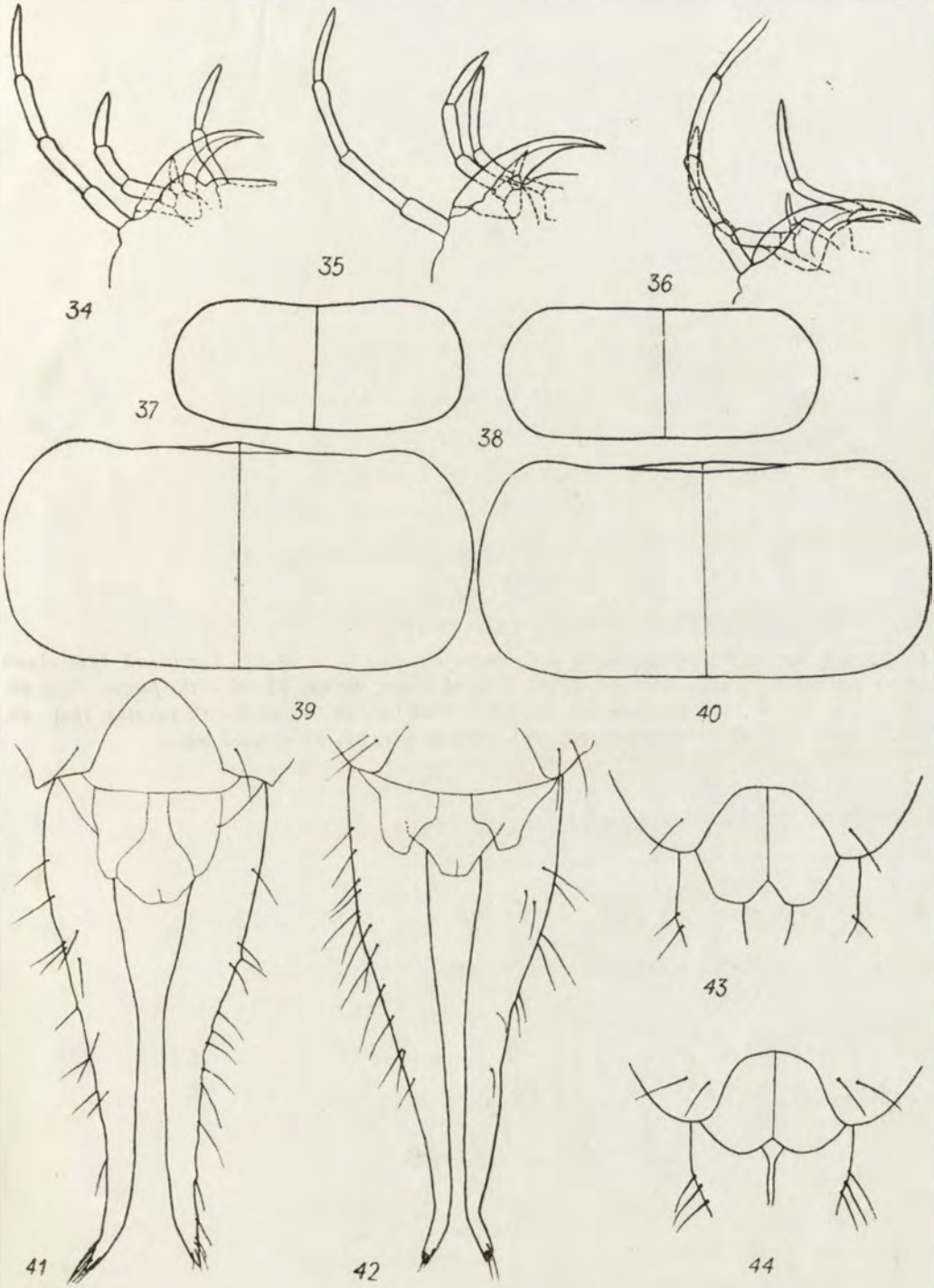
Figs. 28-33. Larvae. Appendages and lateral margin of head
28, 30, 32. Second stage. 29, 31, 33. Third Stage. 28, 29 — *Colymbetes fuscus* (L.), 30, 31 — *C. striatus* (L.), 32, 33 — *C. paykuli* Er.



Auctor del.

Figs. 34–44

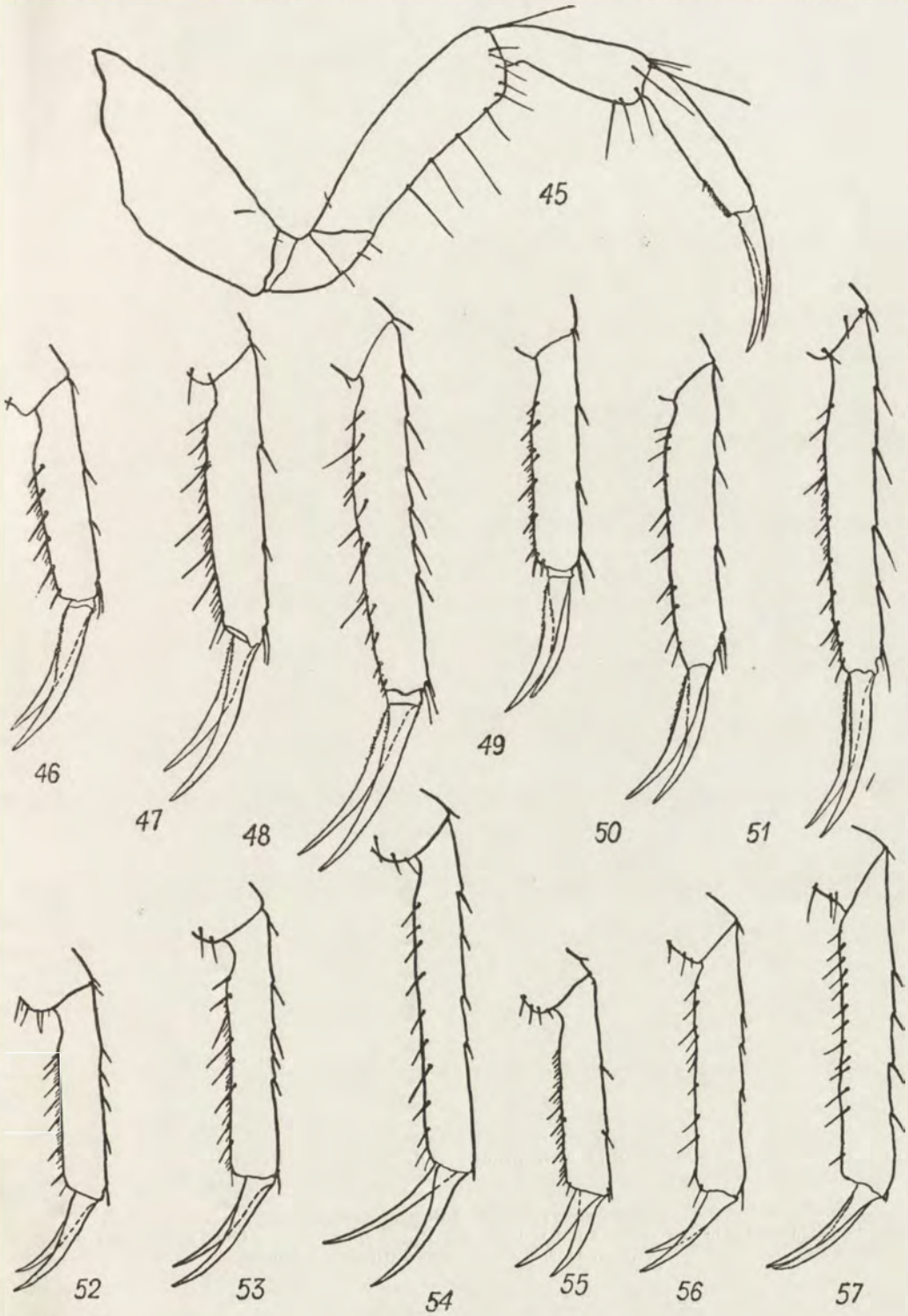
34–36. Appendages of head of larvae of first stage. 34 — *Colymbetes fuscus* (L.), 35 — C. *striatus* (L.), 36 — *C. paykulli* Er. 37–40. Pronota of larvae. 37–38 — first stage, 39–40 — second stage. 37, 39 — *C. fuscus* (L.), 38, 40 — *C. striatus* (L.). 41–44. Pupae. 41–42 — apex of last abdominal sternum, gonopods and cerci ♂. 41 — *C. fuscus* (L.), 42 — *C. striatus* (L.). 43, 44 — apex of last abdominal sternum and gonopods ♀. 43 — *C. fuscus* (L.), 44 — *C. striatus* (L.).



Auctor del.

Figs. 45–57

45— Front leg of first stage larva of *Colymbetes fuscus* (L.). 46–57. Tarsi and tars claws of larvae. 46–51 — second stage, 52–57 — third stage. 46–48, 52–54 — *C. fuscus* (L.), 46, 52— front leg, 47, 53 — middle leg, 48, 54 — hind leg. 49–51, 55–57. *C. striatus* (L.). 49, 55 — front leg, 50, 56 — middle leg, 51, 57 — hind leg.



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