GUIDE TO MONOGENOIDEA OF FRESHWATER FISH OF PALAEARTIC AND AMUR REGIONS

O.N. PUGACHEV, P.I. GERASEV, A.V. GUSSEV,
R. ERGENS, I. KHOTENOWSKY

Scientific Editors

P. GALLI
O.N. PUGACHEV
D. C. KRITSKY

LEDIZIONI-LEDIPUBLISHING

Via Alamanni 11 Milano
http://www.ledipublishing.com
e-mail: info@ledipublishing.com

First printed: January 2010

Cover by Ledizioni-Ledipublishing

ISBN 978-88-95994-06-2

Front cover: /Dactylogyrus extensus,/ three dimensional image by G. Strona and P. Galli.

INTRODUCTION

The first key to parasites of freshwater fish of the USSR was published in Russian in 1962 and was translated into English in 1964. It was a one volume book that included keys for all parasite groups to the species level. Its translation is only one available internationally to present day. The second edition, also in Russian, was published between 1984 and 1987 and consists of three volumes (editor-in-chief O.N. Bauer). The second volume deals mostly with monogenenans (editor A.V. Gussev) and includes 24 keys and 16 supplements. In this volume, the Dactylogyridae (*sensu* Bychowsky et Nagibina, 1978) includes seven genera, and two separate keys can be used to identify over 200 nominal *Dactylogyrus* species. Three keys identify about 50 species in two subfamilies of the Ancyrocephalidae (*sensu* Bychowsky, 1937), and the Tetraonchidae includes 20 species. Keys for four genera in the Gyrodactylidae identify about 150 nominal species. For the polyopisthcotyleans, several keys can be used to identify more than 30 species from 10 genera. Overall, about 500 species of monogeneans can be identified to species level using the keys and supplements in this book. Thus, this volume became popular among ichthyoparasitologists, despite it being written in Russian. Currently, it is a rare book.

More than 20 years have passed since the second edition was published, and many new monogenan species have been described. New data from different countries exists, and some revisions to different monogenean taxa have been published. Therefore, preparation of a second edition English language "Guide to the Monogenoidea of Freshwater Fish of the Palaearctic and Amur Regions" seems to be of current importance.

Because fish parasites, especially monogeneans, follow their host's distribution, in general fish zoogeography reflects monogenean distribution. The terms "Palaearctic" and "Nearctic" are not zoogeographical units but can be used for notational convenience (Banarescu, 1992).Palaearctic defines the Eurasian part of the Holarctic that includes the Euro-Mediterranean, Circumpolar (the Asian part) (Berg, 1949), Baikal, and western Mongolian subregions. The Sahara marks a sharp southern border between northwestern Africa which belongs to Palaearctic and contains mainly European aquatic fauna, and tropical African and Ethiopian regions. In contrast, vague borders exist in western Asia: Southern Anatolia, the entire Near East, central and southern Iran, and parts of Afghanistan must be considered as transitional areas between the Euro-Mediterranean subregion and the South Asian subregion of the Sino-Indian region (Banarescu, 1992). The same is true for the Amur River, which is transitional area between the Circumpolar subregion and the Sino-Indian region. Considering that a number of fish species from the Amur River were introduced into European aquaculture, a separate key for *Dactylogyrus* species of Amur River fishes is included in this edition, in contrast to species from other transitional areas which are inserted to a common keys. Some precise data on monogenean distribution can be found in Pugachev's (2002) "Checklist of the Freshwater Fish Parasites of the Northern Asia" and Moravec's (2001) "Checklist of the Metazoan Parasites of Fishes of the Czech Republic and Slovak Republic (1873–2000)."

When adding newly described species and species from new geographic regions to the keys from the 1985 publication, it seemed prudent to retain the structure of the keys. This provides continuity between the previous and current editions of the book that would have been lacking if the keys were completely revised. Moreover there is no modern accepted monogenean classification. Although the more conservative monogenean classification was used in this edition, it does not greatly influence the identification process. Therefore, some monogenean groups maintain their systematic status (e.g., order Tetraonchidea, family Ancyrocephalidae, etc.). However, some groups obviously need revision (e.g., genera *Dactylogyrus* and *Gyrodactylus*).

Many changes were made in this edition of the book. For simplicity, the small theoretical chapters (e.g., infection pathways of monogeneans and marine monogenean species) from the second edition were excluded from this one. A new family—Bothitrematidae, with the genus *Bothitrema*—was added to the common key of families. The key for *Dactylogyrus* now includes 62 additional species, and the key for *Gyrodactylus* now includes 25 new species. The key for the

Tetraonchidae was completely revised, and the key for the Diplozoidae was reconstructed from Khotenovsky (1985b). Altogether 97 species were added to the different keys, yielding a total of 622 valid species with more than 200 synonyms and 714 figures for the Palaearctic monogeneans and species which are not found yet in the Palaearctic but theirs discovery in the future is extremely probable.

The principle behind dichotomic diagnostic keys consists of comparing characters presented as numbered items in the form of "thesis – antithesis." Before beginning the process of identifying a given monogenean, detailed data must be collected, including the form and size of the body, site, or organ (e.g., haptoral armament, copulatory organ, vaginal armament, etc.). The subclass is the first taxon to be determined, followed by the order and family to which a given specimen belongs.

The identification process proceeds as follows. Identification begins with the first key item. Both the thesis and antithesis must be read carefully. The antithesis number is in parentheses. If the parasite possesses all of the features included in item 1 and there is no Latin name at the end of that item, then proceed to item 2 and again compare the thesis and antithesis. If the features of a given thesis do not match the specimen characteristics, proceed to the antithesis and then to the next item. This process continues until the Latin name is reached at the end of a suitable item that corresponds to the characters of the specimen in question. The keys to species contain a brief description with a reference to the appropriate figures, hosts, and geographical distribution. Geographical distribution is characterized mainly using either host range or river basins or sea basins. In some cases, state names were used, taking into account the latest changes in Europe and the former Soviet Union.

Latin names of fish species are in accordance with the "Catalogue of Fish Names" (Eschmeyer, 1998; www.calacademy.org) or Fishbase (www.fishbase.org) All keys that are part of the Russian edition were translated by O.N. Bauer and O.N. Pugachev. All indexes, host-parasite lists, and literature were prepared by Mrs. Irine Pugacheva. The authors would like to thank Dr. Nina Bogutskaya for consultations about fish classification (especially the Cyprinidae) and Mrs. Lidia Yunchis and Mr. I.A. Levakin for important technical support.

Class Monogenoidea (van Beneden, 1858) Bychowsky, 1937

Monogenoidea are parasites of aquatic cold-blooded vertebrates, rarely of invertebrates (cephalopods and arthropods are known hosts), and of aquatic mammals (*Hippopotamus*). Several Monogenoidea are endoparasites that live in the excretory organs, coelom, intestine, oviduct, and heart. Monogenoidea mostly are host specific.

Parasitic flatworms generally have an elongated and dorsoventrally flattened body. Body size is 0.15–20.0 mm long (rarely up to 30.0 mm). The body usually is cigar shaped or spindle shaped, but in some cases it is leaf-like. Two to six lobes at the anterior end of the body bear cephalic gland duct openings; in rare cases, only one lobe or a sucker is present. In some cases, the lobes bear pits or have been transformed into glandular lappets. The posterior end of the body is more-or-less distinct from the rest of the body and consists of the organ of attachment: the haptor. It bears chitinoid (keratoid) structures of different shapes: marginal hooks, anchors, connective bars, clamps, muscular septae, pits, suckers, thorns, projections, and additional discs. In some cases the whole haptor has been transformed into a powerful sucker. The number and shape of these structures are very important in monogenean taxonomy.

The body is covered with sincitial submerged epithelium. Muscular layers consisting of circular, diagonal, and longitudinal fibrils are situated under the basal membrane. Longitudinal fibrils often are concentrated into powerful bundles that are used to move the structures of the haptor. The space between organs is filled with parenchyma. Muscular fibrils of the parenchyma are weakly developed, except for those that play a role in the functioning of the genital organs and ducts. Sometimes the tegument forms folds and thorns that help with attachment to a substrate (e.g., fish gills). Such structures have been described in dactylogyrids from Amur River fishes and in diplectanids.

The oral aperture usually is subterminal, leading into an oral funnel. In certain groups of higher Monogenoidea, the walls of the oral funnel contain a pair of suckers. The oral funnel leads to the peripharyngeal bursa, and the muscular pharynx juts into the bursa. An esophagus may be present or absent; when absent, the pharynx leads into the entodermal intestine. Higher monogeneans and polystomatids have a bucco-esophagial duct of unknown function, which turns around the pharynx and connects the oral cavity with the intestine. The intestine usually has two trunks (in rare cases, just one) that extend to the posterior end of the body. They may be smooth and cylindrical in form or they may have numerous secondary lateral branches, which sometimes fuse to form a net. The main branches terminate blindly or merge posteriorly to form an elongated ring (Fig. 1A, B).

The excretory system consists of flame cells and a system of long ducts, which have two apertures at both sides of the body at the pharyngeal level.

The nervous system contains a pair of cephalic suprapharyngeal ganglia or a peripharyngeal ring and 3–4 anterior and 2–3 posterior pairs of nerve trunks. Polyonchoinea and Diclybothriidae have two (in rare cases one) pairs of eyes or eyespots above or anterior to the pharynx. Most Oligonchoinea and some Polyonchoinea have eyes in the larval stages only; in adults, the eyes disintegrate into separate pigment particles that are scattered along the anterior end of the body (e.g., *Acolpenteron*, *Bychowskyella*) or disappear completely. In rare cases, eyes are absent at all stages of development. Nipples, papillae, and sensillae are scattered on the body surface. Their number and distribution are specific to each group. They seem to play a role in mechanical and chemical reception.

Monogenoidea are hermaphrodites. They may have one, two, or many testes that lie mostly in the posterior half of the body either behind the ovary, overlapping it, rarely on both sides of it, and very rarely in front of it. The vas deferens (spermaduct) (paired in *Paradiclybothrium*) extends from the testes forward or turns around the left intestinal trunk and comes to an ejaculatory duct. The vas deferens forms a seminal vesicle in front of the ejaculatory duct. The latter, together with prostatic and other gland ducts, opens through the copulatory organ into the genital atrium. The copulatory organ is a muscular penis, or eversible cirrus (sometimes with chitinoid hooklets), or a chitinoid tube supported by a chitinoid structure (the accessory piece). The structure and shape of the copulatory organ and the structure of the haptoral armature are important in taxonomy.

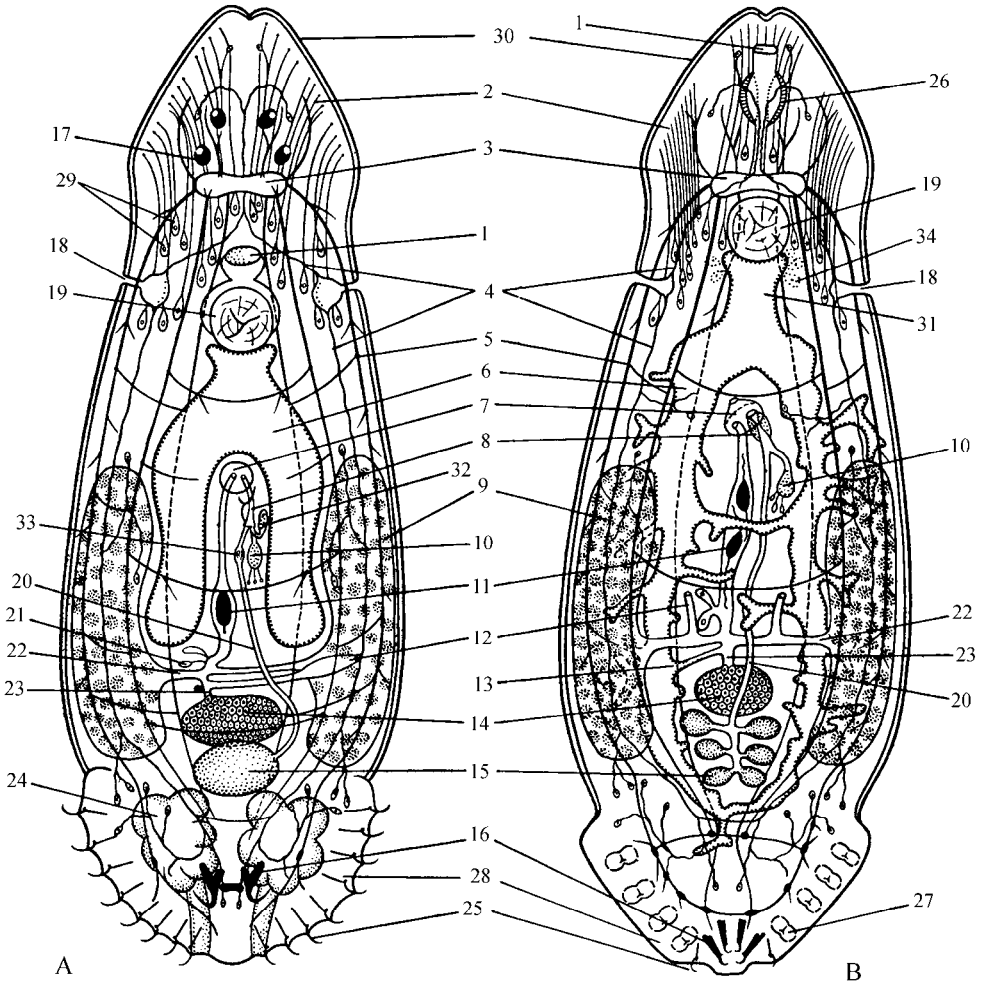


Fig. 1. Scheme of monogenean morphological structure (after Gussev, 1985).

A – lower monogenea (Polyonchoinea); B – higher monogenea (Oligonchoinea). 1 - oral aperture, 2 - cephalic gland ducts, 3 - cephalic suprapharyngeal ganglions, 4 - excretory system, 5 - nerve trunks with commissural nerve fibers, 6 – intestine, 7 - genital atrium, 8 – copulatory organ, 9 – vitellaria, 10 – prostatic glands reservoir, 11 – uterus (ootype) with eggs, 12 - vaginal ducts, 13 - genitointestinal canal, 14 – ovary, 15 – testes, 16 – anchors, 17 – eyes, 18 – aperture of excretory system, 19 – funnel, 20 – spermaduct (vas deferens), 21 - unicellular shell glands (Mehlis' glands), 22 – vitellaria ducts, 23 – oviduct, 24 – glands of posterior body end and haptor, 25 – marginal hooks, 26 – suckers of oral funnel, 27 – clamps, 28 – haptor, 29 - cephalic gland, 30 - cephalic lobes, 31 – esophagus, 32 – gland reservoir with granular secret, 33 - seminal vesicle.

The ovary is always single, and in most cases it is situated anteriorly to the testes. In several groups (*Pseudomurraytrema* from freshwater bodies of North America, Diplectanidae, Monocotylidae, Monchadskyellidae, and Amphibdellatidae from marine fishes), an elongated ovary loops around the right intestinal trunk. The vitellaria and vaginal ducts and the genitointestinal canal fall into a short oviduct. Vitellaria consist of one, two, or more follicular glands that occupy most of the space from the pharynx to the haptor between the intestine, genital glands, ducts, and copulatory organ. The ducts of the left and right vitellaria glands usually fuse into a common duct. A vaginal duct (vagina) is present in most cases; most often it is single, but in some cases it is bifurcated or paired, and sometimes it begins at the vitellaria duct rather than the oviduct. The vaginal pore often is on the lateral side of the body, but frequently it is displaced dorsally or ventrally. In some cases the vaginal duct dilates to form a seminal receptacle. Numerous species bear special chitinoid vaginal armature, which frequently is tube or funnel shaped. A genitointestinal canal is present in all Oligonchoinea and in some of the higher Polyonchoinea (Polystomatidae). The oviduct comes to the ootype in which egg formation occurs. Unicellular shell gland (Mehlis' glands) ducts fall into it. In some Monogenoidea, groups of eggs are deposited into the ootype for a short time before being released into the water through the genital atrium. In such cases, the ootype acts as a uterus. Other groups have a real uterus where completely formed eggs accumulate and remain for a long time to undergo full or partial embryonic development. In some species, hatching of larvae takes place in the uterus (i.e., ovoviviparity). Eggs may be spherical, oval, pyramidal, and so on. One pole of the egg contains a cap. Small pedicules and filaments may originate from one or both poles, or both poles may be free of processes.

Gyrodactylidae do not form such eggs; rather, embryos develop in the uterus and emerge when mature. Embryos of the second and third generations develop in the embryo of the first generation. Thus, Gyrodactylidae have vitellaria in the form of vitelline chambers or "ovary-vitellaria," which are situated by the posterior part of the intestinal caeca and behind the gonads.

Eggs of oviparous groups either are released into the water or attach to the gills or skin of fish by clinging or sticking to host tissue using pedicules or filaments (some marine groups). Oviparous "oogyrodactylids" have a droplet of "sticky" material on their egg filament that is used to attach themselves to hard surfaces of their hosts or to substrates such as sand grains. Embryonic development of eggs outside parasite under optimal conditions takes 2 days to 3 weeks, seldom longer; the time is particular to the species. Cigar-shaped free-swimming larvae called oncomyracidia are covered by cilia and bear sensillae, the distribution of which is species specific. Oncomyracidia have cephalic glands, 2–4 eyes (in rare cases eyes are absent), a pharynx, saccular or annular intestine, and developed nervous and excretory systems. The posterior end of larvae (except Diplozoidae) has marginal hooks, sometimes primordiums of anchors and clamps. The number of marginal hooks in Polyonchoinea larvae is usually 14–16 (more often 14) and in Oligonchoinea is 10 (sometimes 14–16).

Oncomyracidia find their hosts either actively or passively via the water current. When they reach their host, they attach, shed cilia cells and part of the sensillae, then undergo morphogenesis. Monogenoidea undergo direct development without an intermediate host or alternating generations.

How monogenean larvae reach the gills of fish is still unknown, but two current hypotheses are that: 1) larvae primarily attach to fish skin, shed their cilia, and then move to the gills during growth; and 2) larvae reach the gill cavity through the fish mouth via the water current and then attach to the gills. Although more than 10,000 adult fish have been carefully examined, monogenean oncomyracidia (except gyrodactylids, udonellids, and anoplodiscids) never have been found on fish skin, and it is doubtful that they were overlooked. Nevertheless, different postlarval stages have been found on the gills of many adult fishes. For example, Lambert (1979) found *Micropterus salmonoides* infected with larvae of *Urocleidus principalis*, and his experiments suggested that Monogenoidea infect fishes through the mouth rather than attaching to the skin.

Another situation takes place when we investigate young fishes. Dactylogyridae and

Tetraonchidae at different stages of development including mature worms have been found many times on the skin of fish larvae and fingerlings (Bauer et Nikolskaya, 1954; Prost, 1963; Kearn, 1968; Gussev et Kulemina, 1971a, 1971b; Lambert, 1975, 1977a, 1977b; and others) and in lesser quantity on their gills. These data are contradict to Lambert's premise that the main way for Monogenoidea to reach the gills is through the skin and not passively through mouth, which is not very widely observed in nature conditions. Data discussed by many authors (including Lambert) correspond to the opinion of Gussev et Kulemina (1971b) that young fishes are infected through the skin and older ones through the mouth. In contrast, Evlanov (personal communication) have found on the skin of mature specimens of roach as well as some other species of fishes investigated from the lakes of Kaliningrad district rather numerous young dactylogyrid worms. This problem is to be studied in future more carefully. We can't exclude opinion that way of infection is conditioned not only by age of fish but by environmental conditions not known as yet. Kearn (1968) et Lambert (1977b) are perhaps right when they say that way through skin shows that skin was the primarily habitat for larvae of Dactylogyridae. This way prevents delicate gills of fry not to be hurt by anchors of parasite. Possibly**,** that at this stage of fish development monogenean larvae can't establish on gills.

The diet of the Monogenoidea consists of epithelium cells, secretions, and blood. The majority of freshwater Dactylogyridea and Gyrodactylidea feed on mucus and epithelium cells, and only some of them (***Dactylogyrus vastator*** for example) also consume blood. For some of the Tetraonchidae, blood is an important part of the diet, and the higher Monogenoidea as well as the Polystomatidae feed mostly on blood.

Classification of the class is still under discussion. Even the name of the class—Monogenoidea or Monogenea—is controversial. The main goal of any key is species identification, and the classification of Gussev (1985) has been used in this edition. Class Monogenea/Monogenoidea is divided into two subclasses(Fig. 1): 1) lower or Polyonchoinea, with 6 orders and about 30 families and 2) higher or Oligonchoinea with 5 orders and about 35 families.[1] In the first subclass, representatives of 6 families within four orders (Dactylogyridae, Ancyrocephalidae, Capsalidae, Tetraonchidae, Bothitrematidae, and Gyrodactylidae) have been found on Palearctic freshwater fish. The second subclass is represented in this region by five families within two orders (Diclybothriidae, Mazocraeidae, Discocotylidae, Octomacridae, and Diplozoidae).

The majority of Palaearctic freshwater Monogenoidea belong to the first subclass and to the Dactylogyridae and Gyrodactylidae families. These are the most minute worms among the Monogenoidea, with body length ranging from 0.2 to 1.5 mm. Their small size makes them difficult to study.

The following characteritics are of most value when identifying the Monogenoidea:

1. Manner of attachment to different host organs (skin and gills mainly)
2. Shape and size of body and haptor
3. Structure of anterior end; presence or absence of lobes, lappets, suckers and their number
4. Structure of the tegument, its width, and presence or absence of folds, scales, or thorns
5. Presence or absence of eyes, their number, and their structure
6. Chitinoid structures of the haptor
7. The shape, number, arrangement, orientation, and size of haptor structures
8. Structure and size of the copulatory organ

[1] There are three main points of view about the number of subclasses of the Monogenoidea:

1. Monopisthocotylea (= Polyonchoinea) and Polyopisthocotylea (excluding Polystomatidae and Sphyranuridae = Oligonchoinea)
2. Polyonchoinea, Polystomatinea, and Oligonchoinea (Lebedev, 1995)
3. Polyonchoinea and Heteronchoinea (including two infrasubclasses Polystomatoinea and Oligonchoinea) (Boeger and Kritsky, 2001)

9. Intestine structure
10. Number of testes
11. Shape and arrangement of the ovary
12. Correlation of ovary and testes size; their placement relative one to another
13. Number, shape, and situation of the gland reservoirs of the copulatory organ
14. Vas deferens course and shape of the seminal vesicle
15. Position of genital and vaginal pores, course and armament of vaginal duct and of seminal receptaculum (if present)
16. Species and age of host; localization and microlocalization of parasite (i.e., on what part of the host organ it is living)

Extremely important to the identification of the parasite is the correct identification of the host fish species. Even a small error in host identification can result in wrong conclusions. If a parasite is found on an unusual fish species, it is crucial to carefully identify the fish. Errors frequently occur when a hybrid fish is found and identified as the species of one of the parents. Some authors have included such parasites in lists of this or that fish species. In this Key, such questionable parasite occurrences are noted with a comment or a question mark in the list. Obvious cases have been unconditionally omitted.

In addition, this edition of the guide includes the following supplements and comments:

1. Species described after 1985 and those that are absent in Gussev (1985)
2. Parasites of fishes common in Palaearctic water bodies or that rare enter them
3. Species described from water bodies of transitional areas
4. Parasites of marine fishes that enter estuaries of rivers and migrate long distances upstreams
5. Doubtful species described insufficiently with bad drawings and even without a drawing are included as species inquirenda.

In some cases, comments have been added about morphology, biology, and species origin. Some of these comments have no direct role in species identification, but the information is helpful from an analytical perspective.

Several representatives of Monogenoidea become pathogens in high fish density culture systems and are not observed in natural bodies of water. Some pathogens greatly affect the young fish. For example, fish mortality caused by *Dactylogyrus vastator, D. extensus, D. lamellatus, D. magnihamatus, Gyrodactylus cyprini, G. katharineri, G. medius, G. salaris, G. sprostonae, G. anguillae, Nitzschia sturionis, Thaparocleidus vistulensis,* and *Salmonchus grumosus* has been reported. Such cases, with a description of control measures, are noted in this guide.

In most cases, descriptions of different groups are given for mature parasites; these descriptions are not the same as for larvae and postlarvae. When the size of chitinoid structures and parasite localization are used as criteria for species identification, these data are based on parasites from mature fishes if not otherwise specified. Morphology and biology of Monogenoidea are variable in many cases. Localization and microlocalization, as well as some morphological and morphometrical features, may vary depending on the host's size and age or other environmental factors. Moreover, Monogenoidea can be found on non-specific hosts; this often occurs at the border of the host's distribution area.

Most drawings show haptor structures, but with only half of the marginal hooks or only one hook shown, and the copulatory organ in different position and the vaginal armament. In some cases, drawings show the whole haptor, different variations of anchors, dorsal and ventral bars, the fan-shaped bar (in Tetraonchidae), parts of the body and tegument, haptoral armament of the larvae, eggs, clamps and their sclerits, and schemes of anatomical structure. The scale of magnification is given in most of drawings without a legend (each division is 0.01 mm).

Explanation of abbreviations in figures:
VA – ventral anchors
AH – armament of the haptor
ALH – armament of the larvae haptor
FB – fan-shaped bar
VT – vaginal tube (vaginal armament)
VB – ventral bar of the haptor
Hk – marginal hooks
CO – copulatory organ
BE – body edge
Hp – haptor
An – anchor
DB – dorsal bar
DA – dorsal anchor
Eg – egg

Key to subclasses, orders, families, and subfamilies
(Freshwater Monogenoidea only)

1 (13). The haptor has 7–8 pairs of marginal hooks and 1–3 pairs of anchors (in some taxa anchors are lost); sometimes the haptor has been transformed into a big sucker; clamps absent.
Subclass Polyonchoinea

2 (12). Oviparous Monogenoidea; in most cases two pairs of eyes are present.

3 (10). The armament of the haptor consists of seven pairs of marginal hooks and 1–2 pairs of anchors (sometimes reduced); the intestine is divided into two caeca; parasites of different fish orders.
Order Dactylogyridea
Suborder Dactylogyrinea

4 (9). The small worms are usually less than 2.0 mm long; the haptor has not been transformed into a sucker; it has 1–2 pairs of anchors (sometimes reduced) and bars connected to the anchors; the intestine caeca have no diverticula; only one testis is present; mainly parasites of Cyprinidae, Siluridae, and Percidae.

5 (6). Only one pair of anchors (sometimes reduced) is present; a pair of needle-shaped structures is present near the second pair of marginal hooks; the overwhelming majority of species are parasites of Cypriniformes (mostly Cyprinidae).
Family Dactylogyridae
Subfamily Dactylogyridae

6 (5). Two pairs of anchors usually are present (in Palaearctic species); needle-shaped structures are absent; mostly parasites of Perciformes, Siluriformes, and Cypriniformes.
Family Ancyrocephalidae

7 (8). Both pairs of anchors are the same size and shape in representatives of the Palaearctic and Amur regions; patches are absent; two bars are present; in most cases parasites of Perciformes and Cypriniformes.
Subfamily Ancyrocephalinae

8 (7). Dorsal anchors (in some cases ventral anchors also) are present, in most cases with additional patches; there are two or three bars (in the latter case, the ventral bar is divided into two parts); parasites of Siluriformes.

Subfamily Ancylodiscoidinae[2]

9 (4). The large worms are longer than 10.0 mm; the haptor has been transformed into a big sucker; there are three pairs of anchors; bars are absent; the intestine caeca has diverticula; many testes are present; parasites of Acipenseridae.
Order Capsalidea
Family Capsalidae

10 (3). The armament of the haptor consists of eight pairs of marginal hooks, 1–2 pairs of anchors, one bar, and a pair of fan-shaped bars the latter sometimes are absent (e.g., Bothitrematidae); the simple monocormic intestine; parasites of Salmonidae, Coregonidae, Thymallidae, Esocidae, and Cottidae.
Order Tetraonchidea[3]
Family Tetraonchidae

11 (10) The haptor is patelliform and armed by numerous radial supporting plates. The marginal hooks are of the gyrodactyloid type.
Family Bothitrematidae[4]

12 (2). Viviparous worms; eyes are absent (in Holarctic region species)
Order Gyrodactylidea
Family Gyrodactylidae
Subfamily Gyrodactylinae

13 (1). The haptor is armed with modified suckers that have horseshoe axial sclerites or folding clamps; most parts of the larval hooks disappear during postlarval development.
Subclass Oligonchoinea

14 (15). The haptor is armed with six clamp-like suckers with horseshoe-shaped strong axial hook-like sclerites and a finger-like process at the posterior end; this process has a pair of axial sclerites, rudiments of suckers, two pairs of anchors, and one pair of marginal hooks; eyes are present; parasites of Acipenseridae.
Order Diclybothriidea
Family Diclybothriidae

15 (14). The haptor is armed with four pairs folding clamps; eyes are absent in mature specimens; parasites of bony fish (parasites of Clupeaformes, Salmoniformes, and Cypriniformes in freshwater).
Order Mazocraeidea[5]

[2] Family Ancylodiscoididae (Lim et al., 2001)
[3] Suborder Tetraonchinea of the order Dactylogyridea (Boeger et Kritsky, 2001; Simkova et al., 2003).
[4] Bychowsky (1957a) distinguished the new family Bothitrematidae among the order Tetraonchidea. Boeger et Kritsky (1993) consider the family Bothitrematidae Price, 1936 to be among the order Gyrodactylidea Bychowsky, 1937 according to morphological data. However, according to molecular data ***Bothitrema*** is related to ***Anoplodiscus*** and ***Sundanonchus*** (Justine et al., 2002) while two latter genera are related to ***Tetraonchus*** (Simkova et al., 2003); therefore, all of these genera are considered to be in the suborder Tetraonchinea Boeger et Kritsky, 1993 of the order Dactylogyridea.
[5] Family Microcotylidae is not included in the key, although ***Microcotyle mugilis*** Vogt, 1878 can be found on grey mullet during migration to freshwater.

16 (17). The haptor of mature specimens is armed with one pair of marginal hooks, two pairs of anchors, and four pairs capsule-shaped clamps; the middle clamp sclerite is broad with an aperture; parasites of marine and anadromous Clupeiformes and Perciformes (mostly Scombroidei).
Suborder Mazocraeinea
Family Mazocraeidae

17 (16). The haptor of mature specimens is armed with one pair of anchors and four or more pairs of clamps that do not form capsules; the middle clamp sclerite is narrow and lacks an aperture; parasites of freshwater and marine fishes, predominantly Cypriniformes, Salmoniformes, and Perciformes.
Suborder Discocotylinea

18 (19). During postlarval development, two specimens inosculate to form an X-shaped figure; the intestine has lateral diverticula; one testis is present; parasites of Cyprinidae and rarely of other Cypriniformes.
Family Diplozoidae
Subfamily Diplozoinae

19 (18). Mature specimens do not inosculate; intestine has two caeca; one or many testes; parasites of Salmoniformes and Cypriniformes.

20 (21). A genital sucker is absent; many testes; parasites of Salmoniformes.
Family Discocotylidae

21 (20). A genital sucker is present; one testis; parasites of Cypriniformes.
Family Octomacridae

Subclass Polyonchoinea Bychowsky, 1937

Larvae have 14–16 marginal hooks on the haptor and most have two pairs of eyes. The adhesive apparatus of mature specimens is represented by a haptor with chitinoid armament. In some cases the haptor has been transformed into a large sucker or 2–6 special suckers are on haptor. Chitinoid structures are not reduced during all life stages, except for the Microbothriidae, which is not a monophyletic group. Sometimes two suckers are present on the anterior end of the body. They are not connected to the mouth cavity and are not homologous to the mouth suckers of Oligonchoinea. The mouth is situated between two groups of head glands and sometimes has a terminal sucker. The testis can be unpaired, paired, or numerous and usually lies postovarially. Representatives of this subclass are parasites of Teleostomi and rarely of Elasmobranchii, Holocephali, Cephalopoda, Amphibia, aquatic Reptilia, and Mammalia (*Hippopotamus*). Representatives of four orders and six families of subclass have been found on Palaearctic freshwater fishes.

Order Dactylogyridea Bychowsky, 1937

The larvae of these Polyonchoniea have 14 marginal hooks in the haptor and four eyes in most cases. Mature worms are rather small; mostly are less than 2 mm long. The anterior end of the body has paired groups of cephalic gland opening into 2–3 pairs of mobile lobes; in some cases lobes are not present or they form a glandular ridge. The haptor (sometimes saucer shaped) has seven pairs of marginal hooks and 1–2 pairs of anchors, which in some cases are not present.[6] In

[6] New descriptions of species and genera with a smaller number of marginal hooks are the result of mistakes made because of bad slides on which very thin marginal hooks were not visible. Sometimes greatly modified marginal hooks can be taken for anchors (e.g., genus *Curvianchoratus* Hanek et al., 1974, with "three" pairs of anchors).

rare cases, the haptor has suckers (family Neodactylodiscidae Kamegai, 1971) or 1–2 pairs of needle-shaped structures of unknown nature. In the majority of cases, 1–3 bars (seldom more) are present between the anchors. Additional chitinoid structures (additional pieces of anchors, scute, thorns, or plectanes) are sometimes present. Eyes are present in mature specimens but sometimes disappear. The intestine is bifurcated and usually lacks diverticula. The caeca terminate blindly or merge posteriorly to form an elongated ring. Dactylogyridea are oviparous. The ovary is rounded, elongated, or flask-shaped, and is situated the middle of the body and sometimes turns around the right intestinal trunk. Usually only one vaginal duct is present, but in rare cases there is a pair, and in most cases it opens to the left or right side of the body (sometimes absent?). Quite often vagina has chitinoid lining. The vitellaria are well developed, paired, follicular, and merged behind the pharynx and testis. Usually there is only ootype containing one egg (a real uterus in Linguadactylinae Bychowsky, 1957). In most cases only one testis (rarely more than one e.g., in *Linguadactyla* and *Hareocephalus*) is present; it is rounded or with two, three, or many lobes (*Protogyrodactylus*) and is situated behind the ovary or lies over it. The vas deferens turn around the left intestinal trunk or lies straight between the trunks. The copulatory organ usually consists of a chitinoid tube and an accessory piece. Prostatic glands are present. The male pore lies in the genital atrium near the female pore on the ventral side of the body, in most cases in the middle of the body. Eggs have a short pedicle, sometimes with a filament, and are oval or triangular. Larvae have three cilia zones.

Dactylogyridea are parasites of freshwater and marine teleosts, mostly Cypriniformes, Siluriformes, and Perciformes. These parasites inhabit the host's gills and sometimes the intestine, ureters, and other organs. The order is divided into two suborders: Dactylogyrinea Bychowsky, 1937 and Calceostomatinea (Price, 1937) Gussev, 1977.[7] The first consists of four families and the other of one. Fresh waters of the Palaearctic contain representatives of only two families of suborder Dactylogyrinea. The species of suborder Calceostomatinea are not represented in the Palaearctic.

The suborder Dactylogyrinea is the most numerous and diverse group among the Monogenoidea. The majority of its species live in fresh water. More than 1000 species are known to date. Researchers estimate that this number represents only about 10% of existing species; in South America, no more than 2% of the Dactylogyrinea fauna has been described. The systematics of the suborder is poorly known because the small size of these parasites make them diffcult to study. The majority of species of this suborder can be found in high numbers on many freshwater fish species. For example, a fish specimen can carry not one but two, three, four, five, or up to 10–15 relative species with similar or different microlocalization. Researchers have studied the adaptation of different populations or species to different niches of fish gills (Dogiel, 1949, 1962; Gussev, 1955a; Bychowsky, 1957a etc).

Data on the distribution of monogenean species among different microbiotopes currently is receiving attention as researchers study parasite ecology at the population level. However, few data are available for freshwater monogeneans, even though they are accessible to many laboratories that study such problems. The Monogenoidea is perhaps the most convenient group to study parasite ecology issues, especially the distribution of a given taxon, the age structure of monogenean populations in different bodies of water and in different seasons, and the distribution in fishes of different age and physiological condition. Although these issues are not the focus of this Key, we note the necessity of these data. We have to notice also some special problems connected with diversity of freshwater monogenean morphology. Till now this is studied only for chitinoid structures used in species identification.

[7] The five suborders are: Dactylogyrinea, Calceostomatinea, Tetraonchoinea, Neodactylodiscinea, and Amphibdellatinea (Boeger and Kritsky, 2001).

Family Dactylogyridae Bychowsky, 1933

Members of the Dactylogyridae (suborder Dactylogyrinea) are small in size (in most cases less than 2.0 mm long). The adhesive armament of the haptor consists of seven pairs of marginal hooks, one pair of needle-shaped structures near the second pair of marginal hooks, and a pair of anchors that may disappear secondarily. In this key, numeration of the marginal hooks follows Llewellyn (1963). Five different systems of hook numeration exist (Fig. 2). Two bars (a dorsal and a ventral one) or only the first one lie between the anchors. In rare cases, additional pieces of anchors are present. The body at the anterior end is flattened. It forms 2–3 pairs of lobes where ducts of three pairs of glands open. There are two basic lobes and a third smaller one at each side of the anterior end, which is not always developed. The majority of species has two pairs of eyes. Intestinal trunks lack diverticula and mostly are confluent at the posterior end; in some species they are not confluent. The ovary is rounded in most cases, but it can be elongated, and it is situated between the intestinal trunks. Usually only one vaginal duct is present and it opens on the right side; sometimes it has a chitinoid lining and a seminal receptacle.

Vitellaria are extremely well developed, are paired, and consist of many small follicles. In most cases the uterus is absent and instead an ootype containing only one egg is present. It opens behind the intestinal bifurcation near the male genital pore. Vaginal and vitellaria ducts as well as shell gland ducts usually open into the anterior part of the ootype, which sometimes forms a special chamber. The single testis is situated behind the ovary or lies over it. In some cases the spermaduct turns around the left intestinal trunk and copulatory organ; at its end it becomes broader to form a seminal vesicle.

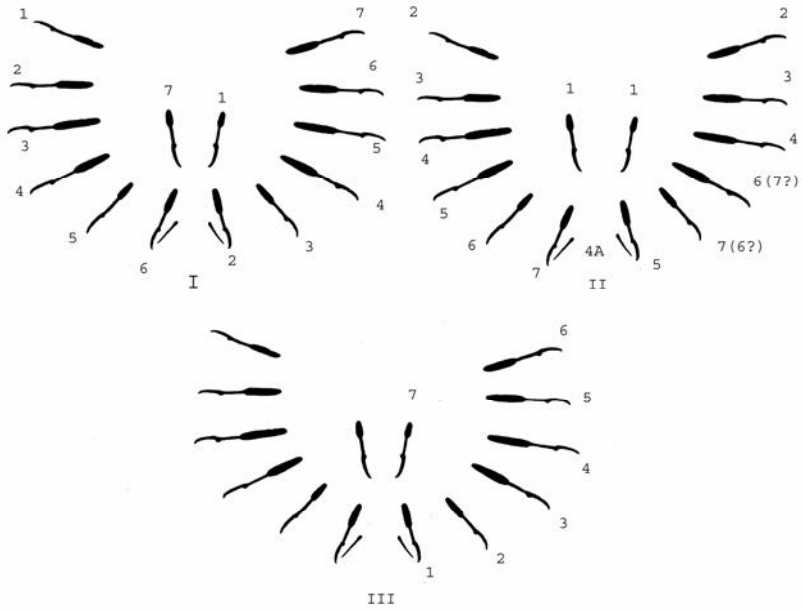


Fig. 2. Marginal hooks numeration.

I, left – by: Kulwiec, 1927 for dactylogyrids and by: Llewellyn, 1957 for diclidophorids, right – by: Llewellyn, 1963 for different groups and by: Euzet et Ktari, 1970 for calceostomatids (both numeration systems based on larvae);
II, left – by: Mueller, 1936, right – by: Mizelle, 1936 (both numeration systems based on adult dactylogyrids);

III – by: Euzet et Ktari, 1970 for all groups except calceostomatids and by: Lambert, 1975 for dactylogyrineans (based on larvae).

The chitinoid copulatory organ consists of a tube and an accessory piece, and two prostatic glands lie near it. Eggs have a short pedicle without a filament; in most cases they are oval, but sometimes they are triangular with lateral swellings.

The Dactylogyridae are gill parasites, mostly of freshwater Cypriniformes. Larvae of many *Dactylogyrus* species and of some other monogenean groups attach to the skin and fins of young fishes (0+) (perhaps also of adult fish) and migrate to the gills during maturation; however, no direct observations of this process exist.

Representatives of seven genera have been reported from fresh waters of the Palaearctic and Amur regions. Bychowsky et Nagibina (1978) separate the family Ancyrocephalidae which previously formed a subfamily of the family Dactylogyridae. Thus only one subfamily remains in this family. We do not agree with Achmerow (1964), who proposed a special subfamily Neodactylogyrinae for all dactylogyrids with two bars. The majority of specialists refuse the validity of the genus *Neodactylogyrus*.

The family contains 9–13 genera. The taxonomic positions of the described genera *Trinidactylus* Hanek et al., 1974, *Curvianchoratus* Hanek et al., 1974, and *Nanotrema* Paperna, 1969 are not quite clear, and the validity of *Dicrodactylogyrus* Luo et Lang, 1981 is doubtful.

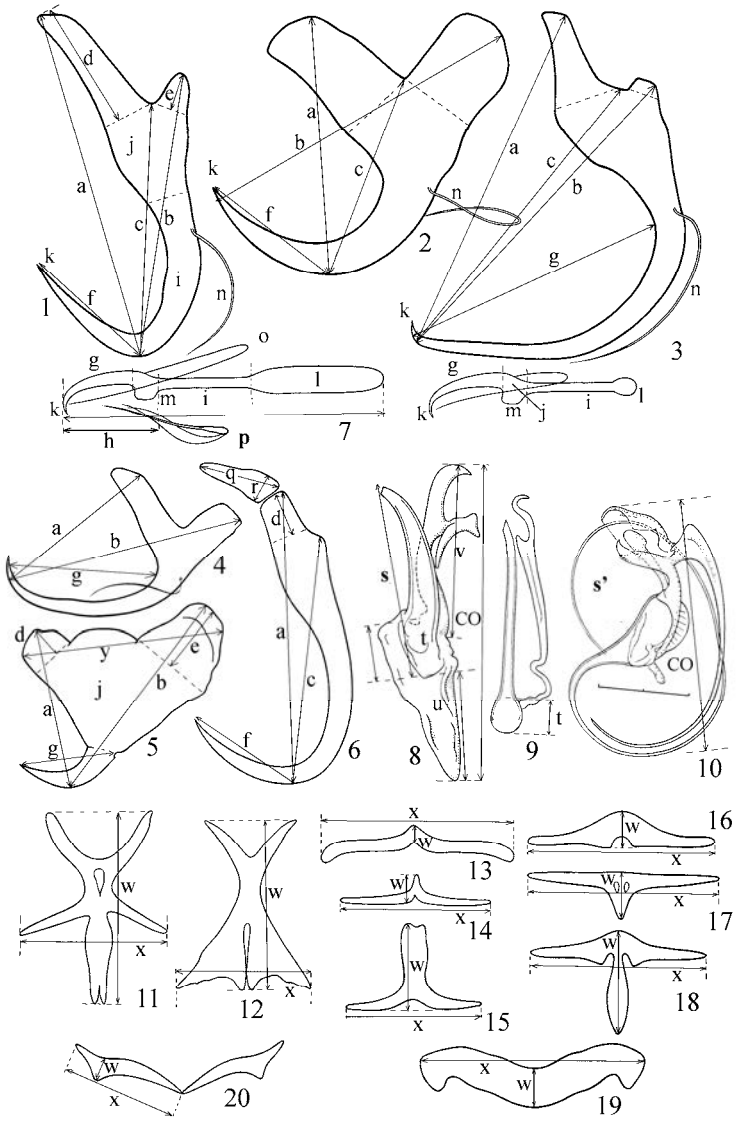


Fig. 3. Monogenean chitinoid structures and their parts with measurement schemes.

Anchors: 1 – *Dactylogyrus wunderi*, 2 – *D. robustus*, 3 – *D. slastnikowi* ("falcatus" type), 4 – *D. vastator*, 5 – *Ancyrocephalus paradoxus*, 6 – dorsal anchors of *Thaparocleidus*; 7 – marginal hooks. Copulatory organ: 8 – *Dactylogyrus intermedius* ("anchoratus" type), 9 – *D. magnihamatus*, 10 – *D. fallax*. 11 – 18: ventral bars of different *Dactylogyrus* species, 19 – more common dorsal bar of *Dactylogyrus*, 20 – ventral bar of *Thaparocleidus*.

Parts of chitinoid structures with measurement schemes: a – inner (dorsoapical for dactylogyrids) anchor length, b – outer (ventroapical for dactylogyrids) anchor length, c – main part length, d – length of inner root, e – length of outer root, f – point length, g – blade length, h – hooklet length, i – pivot, j – hooklet base, k – hooklet tip, l – handle, m – heel, n – wing, o – loop, p – needle, q – r – length and width of patch, s – length of copulatory tube (co – total length of copulatory organ), s' – length along the curve of copulatory organ, t - initial part of copulatory tube, u – projection (base) of copulatory tube, v – accessory piece, w – bar length, x – bar width (for ancylodiscoids – half of bar), y – anchor width (width of anchor main part).

Key to genera of Dactylogyridae

1 (8). The haptor has seven pairs of marginal hooks, one pair of anchors, and one dorsal bar (or sometimes with a ventral bar or both).

2 (5). The anchors have a turned-in point in most cases. The anchors are directed to the dorsal side of the haptor, and in most cases anchors turn towards each other or on the contrary. Usually two bars are present, but in rare cases just one.

3 (4). The ventral bar is almost twice as long as the dorsal one. Two vaginal ducts open dorsolaterally on the sides of the body.
Bivaginogyrus

4 (3). The ventral bar, if present, is shorter or slightly longer than the dorsal one. A single vaginal duct opens at the right side of the body.
Dactylogyrus

5 (2). The anchors more often have an open point; the anchors unfolded frontally; only one bar is present.

6 (7). The anchor points are directed to opposite sides; anchors roots are similar and form an angle greater than 90º or a small inner root and a large outer one; anchors have turned-in point or open point with a blunt end; marginal hooks in most cases are of the larval type.
Pellucidhaptor

7 (6). The anchor points are directed towards each other; opened points sometimes have a sharp break at the end; anchor roots are weekly developed, sometimes poorly visible; marginal hooks usually have a well-developed handle.
Dogielius

8 (1). The haptor lacks anchors; only marginal hooks are present; one or no bar is present.

9 (10). The haptor has one bar.
Markewitschiana

10 (9). The haptor lacks bars.

11 (12.) Mature specimens have two pairs of eyes; the cuticle is thin (~0.001 mm); parasites of gills and fins.
Pseudacolpenteron

12 (11). Mature specimens have two pairs of eyes or none (sometimes pigment grains are distributed on the anterior part of the body); the cuticle is thick (up to 0.003 mm); parasites of ureters.
Acolpenteron

Genus *Dactylogyrus* Diesing, 1850

Syn.: *Neodactylogyrus* Price, 1938; *Paradactylogyrus* Thapar, 1948; *Falciunguis* Achmerow, 1952; *Microncotrematoides* Yamaguti, 1963; *Microncotrema* Yamaguti, 1958 (?); *Aplodiscus* Rogers, 1967; *Gussevianus* Achmerow, 1964; *Skrjabinonchus* Achmerow, 1964 (?)

The haptor of these Dactylogyridae has seven pairs of marginal hooks, one pair of needle-like structures, one pair of anchors pointed to the dorsal side of the haptor (often turning towards each other, rarely on the contrary), and a dorsal bar only or two bars. If both bars are present, usu-

ally the ventral one is smaller than the dorsal one; in rare cases they may be the same size or the ventral is slightly larger than the dorsal. Two pairs of eyes usually are present, but they may be split into grains or absent in some specimens. The intestinal trunks may or may not confluent at posterior end of the body. The genital system is typical for the family; the genital pore is situated medially and the unpaired vaginal duct opens dextrally.[8]

In most cases, these are gill parasites of Cypriniformes: Cyprinidae, Catostomidae, and sometimes Cobitidae. One species, *D. cranoglanis* Gussev, 1966, has been found on gills of a silurid fish, *Cranoglanis bouderius* (Cranoglanididae). Only 15 species have been found on Perciformes and three on a typical marine fish, *Lateolabrax japonicus* (Lateolabracidae). A few species live in the posterior part of their host's intestine, the ovipositor, the fins, or the nasal cavities of some freshwater fishes.

The type species is *D. auriculatus* (Nordmann, 1832).

More than 800 species have been described, and about 240 species are known from the Palaearctic. Many other species have been found in waters of South Asia, Africa, and North America.

The species of this genus have been divided into two groups—parasites of Palaearctic fishes and parasites of Amur-Chinese fishes—and we provide two separate identification keys. The 16 species that have been found in both areas are mentioned in both keys, but their descriptions are given only in the first one. Monogenoidea that have been brought to the Palaearctic with Amur-Chinese fishes, such as grass carp, silver carp, bighead carp, as well as *Pseudorasbora parva* and *Abbottina rivularis* (about 15-20 species of the genus *Dactylogyrus*), are not included in the first key even though they now occur in waters of the Palaearctic as well as in fish farms. Some of these species are dangerous agents of fish diseases (Bauer et al., 1981) (e.g., *D. magnihamatus* is a pathogen of young grass carps in China).

Terms used to describe the chitinoid structures and their parts and measurements are generally the same as those used before (Gussev, 1955a, 1978a; Ergens et Lom, 1970) and are accepted by the majority of investigators. The several changes are made for the anchors with open point or with point, which is poorly delimited from the anchor's main part (examples: *D. vastator*, *D. tuba*, and *D. robustus*). Glaeser's (1965) recommendation for measuring the total anchor length using dorso-apical and ventro-apical length (Fig. 3:1–4a, b) was accepted. After this recommendation was made, both of these lengths have been measured from one dot of the anchor point situated at most distance from anchor root tips. This is correct for most types of anchors with sharp turned-in points (e.g., *D. extensus*, *D. fallax*, and others) and for those with an open point that turns in only at the tip (e.g., *D. falcatus*, *D. tuba*, and several species from Amur River fishes) (Fig. 3:3, 4). However, for some species, such as *D. robustus*, that have a smooth turned-in anchor point dorso-apical length, length of main part and point are to be measured from one dot on the point bend but ventro-apical length from tip of point (Fig.3: 2). These two terms—dorso-apical and ventro-apical length—can be used for the genus *Dactylogyrus* and its related genera; their anchors are directed frontally rather than to the dorsal side of the haptor (e.g., *Dogielius*). Such terms, however, are not valid for groups with two pairs of anchors when one pair is directed dorsal to and the other ventral to the haptor (e.g., Ancyrocephalidae, Diplectanidae, and others). In these families, dorso-apical length of the dorsal pair of anchors becomes ventro-apical length for the ventral pair of anchors, which leads to confusion. Many species of these groups have anchors (or one pair of them) with an open point, and both lengths should be measured for such species. Thus, alternative terms are recommended: inner and outer length (analogous to terms: inner and outer root of anchor). The using these terms for all Dactylogyridae, Ancyrocephalidae, Tetraonchidae, and other families (Gussev, 1983) ensures the semantic match of anchor measurements.

When the point is open, the blade (distance from the tip of the point to the beginning of

[8] Ogawa et Egusa (1977, 1979) reported that the testis lies before the ovary in *D. minutus* and that the vaginal pore is on the left side in *D. dulkeiti*. These data need to be checked.

the main part) must be measured (e.g., *D. vastator*, *D. curvicirrus*, *Ancyrocephalus paradoxus*, and others, Fig.3:3, 4, 5, g). In cases where the length given is not defined (ventro-apical or dorso-apical) and the term "length" or "total length" has been used, it refers to the dorso-apical length (i.e., the distance from the outer side of the point bend or from its tip (if the point is open) to the end of the inner root of the anchor). Such length is the distance between the two farthest dots in most cases (Fig. 3:1, a). When the copulatory organ and vaginal armament with long strongly curved tubes are measured, then length of the tube along the curve, and also total length (i.e., the straight line distance between the two farthest dots) usually are given (Fig. 3:10, s').

Additional information

1. Due to high host specificity, most monogenean species of the genus *Dactylogyrus* are found mainly on one host species or on several congeners or closely related genera (Bychowsky, 1957a). In most cases these fish species or genera have hybrids, which provides evidence of their cognation.
2. If the details of morphological structures are known, it is possible with more or less confidence to recognize some species at the early stages of their morphogenesis based on specific characters of their developing chitinoid structures, such as length, massiveness, point bending of anchor germs, shape of the hooklet heel of the marginal hooks, shape and measures of the blade of different marginal hooks pairs, etc. (e.g., *D. vastator*, *D. robustus*, *D. minor*, *D. bicornis*).
3. Some features used in keys (e.g., the presence or absence of a posterior projection of the bar (i.e., its ⊥ or ┼ like shape)) are easily visible in one specimen and barely visible in another. The same can be said for the anterior projection of the ⊥ like bar. In most cases of the "phoxini" species group it is very short, but in some specimens it is as long as or longer than the side arm (Fig. 4:12, 13). These differences correspond to different theses (e.g., the posterior projection of the copulatory tube can be absent in young specimens), and some of these theses are rather conditional, especially if old data and schematic drawings based on bad slides are used.
4. Many *Dactylogyrus* species can be grouped into many morphological types, which sometimes are distinctly associated with a certain faunistic complex[9]. Each type has its own shape of anchors, marginal hooks, bars, copulatory organ, and vaginal armament. In most cases, morphological groups cannot be isolated using all chitinoid structures at once (i.e., by anchor shape, such groups may have one species composition; by bars another one; by copulatory organ a third one). The most common types of such structures are illustrated in Figs. 4–6. Some of these groups can be viewed as phylogenetic units (e.g., the "anchoratus", "wegeneri", "vastator", "phoxini", "chondrostomi", "linstowi", "kulvieci", and "cryptomeres" groups). However, convergent coincidences have occurred in other groups (e.g., a "sphyrnoid" type of anchor with a single bar in the haptor has been found in several Palaearctic species; the same anchor type has been described in *D. sparsus* and *D. alatoideus*, but with two bars in the haptor. These species form the Amur region are unrelated with Palaearctic species and with each other. Thus sphyrnoid morphological group cannot be viewed as phylogenetic group.
5. High diversity in many monogenean groups leads us to ask which features are more important when determining the degree of relatedness between different species of a genus or related genera? Because the anatomical details of the dactylogyrids are poorly known, the diagnostic features used are the chitinoid structures. We still do not know which features can be used as relationship indices and how these species originated.

The concept of allopatric and alloxenic species seems relevant to answering these questions. These terms refer to species that are found in different regions or on different hosts, in contrast to sympatric and synxenic species that live in the same body of water and on the same hosts (Eichler, 1966). To explain the origin of this group of species is not a problem - that is a common way of geographical or ecological (host) divergence; but which structures were involved in the divergence? Bychowsky (1949) analyzed some monogenean species from closely related hosts and concluded

[9] A faunistic complex is a group of species with similar ecological requirements as a result of a common historical fate and/or long-term coexistence in one geographic zone (Pugachev, 1990).

that the attaching apparatus is more conservative in terms of inheritance compared with the chitinoid structures of genital system. Many examples support this statement, but many exceptions exist as well (e.g., *Dactylogyrus caucasicus*, *D. dimitrovae*, *D. soufii* from *Rutilus rutilus*, *Alburnoides bipunctatus* and *Leuciscus soufii*; *D. linstowi*, and *D. goktschaicus* from Armenia; *D. balistae* from Spain; parasites of different *Barbus* species, some North American species of *Dactylogyrus* - they have a rather identical copulatory organ within each group and rather different chitinoid structures of haptor). Great differences in the structures of the haptor and similarity of the copulatory organ are observed in the Pseudomurraytrematinae and Tetraonchoididae. Thus, Bychowsky's statement is not a rule in the case of allopatric and alloxenic speciation.

However, it also possible to find sympatric and synxenic speciation when species groups have identical armament of the haptor but different chitinoid genital armament and thus correspond to Bychowsky's statement (i.e., the "wegeneri" group from *Carassius*; *D. cornu* and *D. cornoides* from *Blicca bjoerkna* and *Vimba vimba*; *D. difformis* and *D. difformoides* from *Scardinius erythrophthalmus*; *D. ramulosus* and *D. micracanthus* from *Rutilus rutilus* and *Leuciscus idus*; and several species from Amur *Hemibarbus*, Cultrinae, and *Silurus asotus*).

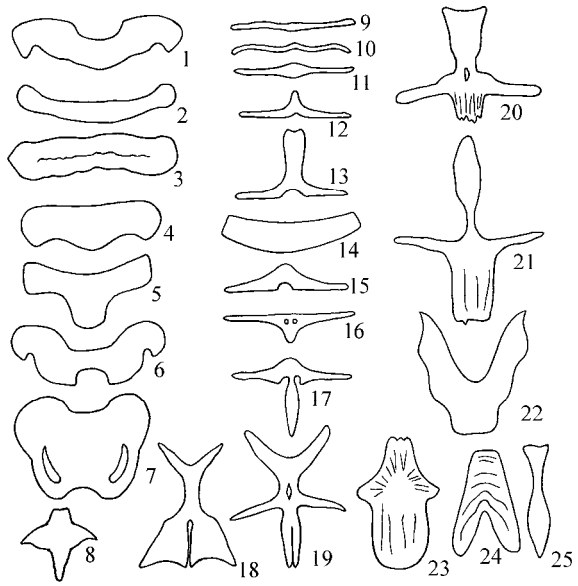


Fig. 4. Bar types of the genus *Dactylogyrus*: dorsal bar (1-8) and ventral bar (9-25) (after Gussev, 1985).

1, 13 – *D. wunderi*, 2 – *D. wegeneri*, 3 – *D. vastator*, 4 – *D. amphibothrium*, 5, 25 – *D. simplicimalleata*, 6, 10 – *D. varicorhini*, 7 – *D. chondrostomi*, 8 – *D. scrjabini*, 9 – *D. magnihamatus*, 11 – *D. tuba*, 12 – *D. phoxini*, 14 – *D. primarius*, 15 – *D. leucisculus*, 16 – *D. zachvatkini*, 17 – *D. erythroculteris*, 18 – *D. crucifer*, 19 – *D. cornu*, 20 – *D. rutili*, 21 – *D. tissensis*, 22 – *D. bicornis*, 23 – *D. markewitschi*, 24 – *D. facetus*.

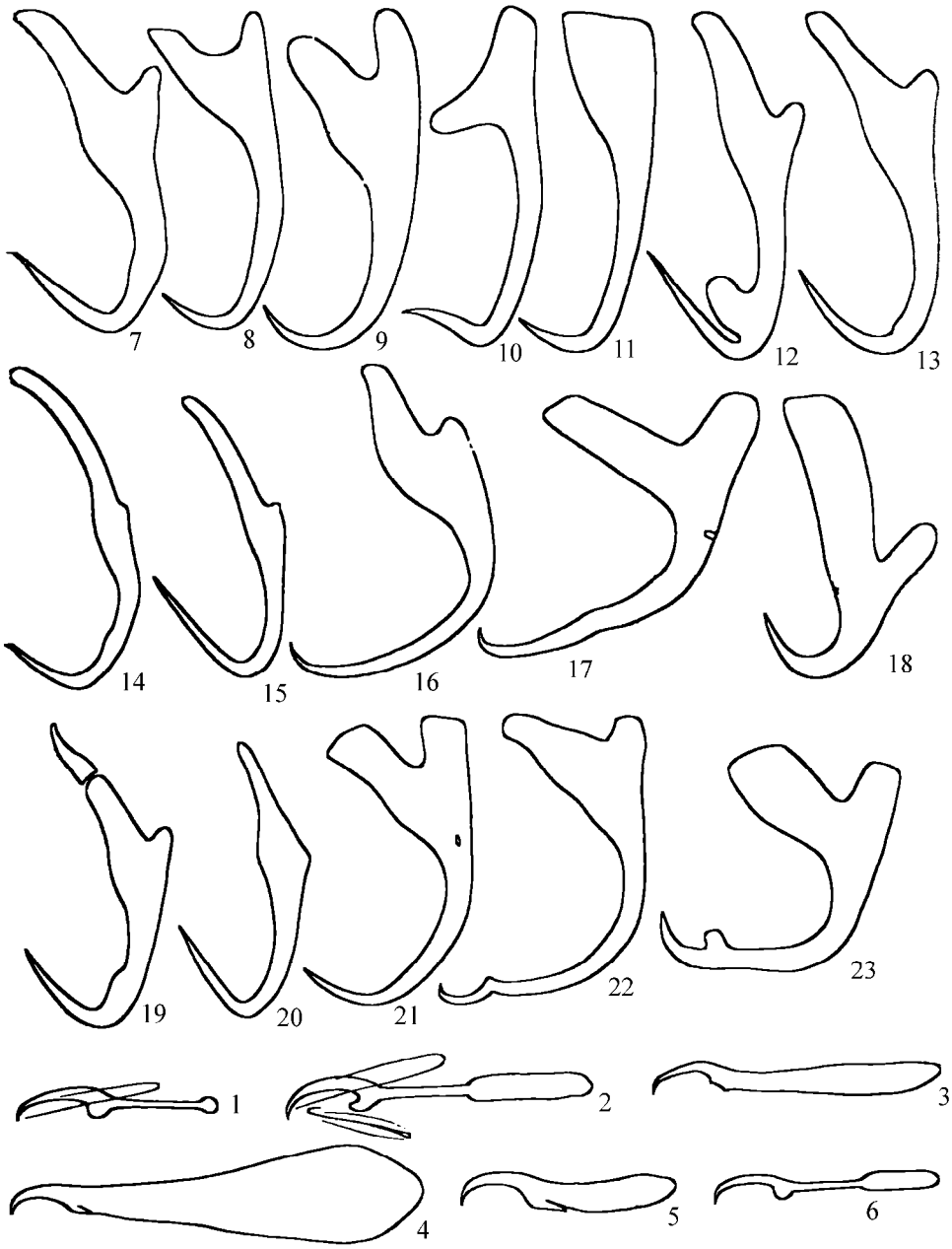


Fig. 5. Different types of marginal hooks (1-6) and anchors (7-23) of the genus *Dactylogyrus* and closely-related genera (after Gussev, 1985).

1 – marginal hook of larvae type, 2-6 – marginal hooks of adult monogeneans: 2 - second pair of marginal hooks with needle-shaped structure, 3 – *D. gotoi*, 4 – marginal hook of the third pair of *D. sphyrna*, 5-6 – marginal hooks of the first and second pairs of *D. wunderi*, 7 - *D. wunderi*, 8 – *D. nanus*, 9 – *D. borealis*, 10 – *Pellucidhaptor merus*, 11 – *D. primarius*, 12 – *D. pterocleidus*, 13 – *D. varicorhini*, 14 – *D. anchoratus*, 15 – *D. wegeneri*, 16 – *D. falcatus*, 17 – *D. vastator*, 18 – *D. sphyrna*, 19 – *D. lamellatus*, 20 – *Bivaginogyrus obscurus*, 21 – *D. extensus*, 22 – *Dogielius forceps*, 23 – *Dactylogyrus falciungius.*

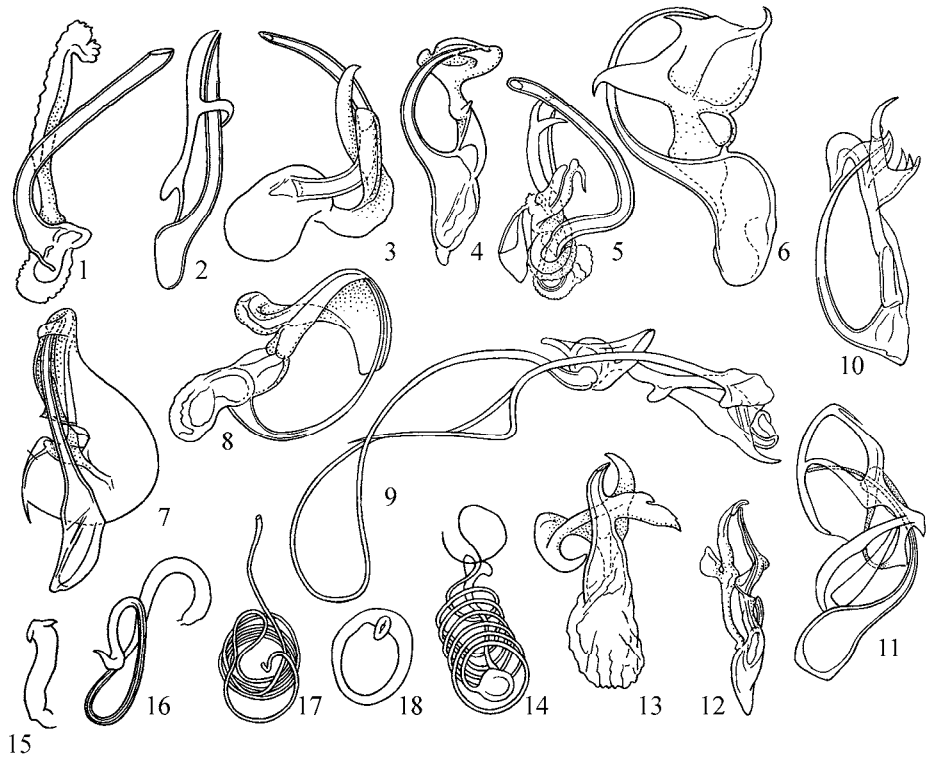


Fig. 6. Some types of copulatory organ (1-14) and vaginal armament (15-18) of the genus *Dactylogyrus.*

1 – *D. extensus*, 2 – *D. anchoratus*, 3 – *D. cryptomeres*, 4, 15 – *D. nanus*, 5 – *D. floricirrus*, 6 – *D. difformoides*, 7 – *D. goktschaicus*, 8, 16 – *D. ergensi*, 9 – *D. wunderi*, 10 – *D. ramulosus*, 11 – *D. malleus*, 12 – *D. achmerowi*, 13 – *D. macracanthus*, 14 – *D. pulcher*, 17 – D. *auriculatus*, 18 – *D. fraternus*.

The sympatric and synxenic speciation could be explained by genetic isolation of micropopulations due to changes of the copulatory organ and vaginas. How these changes could occur without topological differentiation is unclear. Moreover, perhaps these groups originated by an allopatric pathway in rivers isolated by transgression of the sea and then were mixed during ocean regressions (see: Gussev, 1955a, 1978b)?

Lambert (1977a) used the “chondrostomi” group wrongly as an example of isolation due to divergence of the copulatory organ structure. This group illustrates another very common speciation mode. *D. ergensi*, *D. dirigerus*, and *D. soufii* are differentiated not by the shape of the copulatory organ (as within the *D. tuba* group) but by the shape of the anchors (and *D. soufii* also by the shape of the vaginal tube). Lambert wrongly identified one form of *D. ergensi* as *D. dirigerus*, and his *D. toxostomi* is not a new species but a third form of *D. ergensi*. For proper identification, it is necessary to conduct a statistical study of the copulatory organ and vaginal tube structure to discover their differences and to use numerous homogenous materials; moreover, all worms have to be squeezed equally. In Lambert's study, the copulatory organ of "*Neodactylogyrus dirigerus*" was not squeeze enough so that is looked rather differently than the typical copulatory organ of the “chondrostomi” group. The chondrostomi group is one of the most numerous groups based on similar structure of the copulatory organ. *D. chauhani* and *D. yogendrai* from Indian *Cirrhina mrigala* also illustrate deviation from Bychowsky's and Lambert's statements.

Thus, divergence has occurred via different pathways for different groups, in one or more hosts, and in one or more regions, and it has taken place in either the genital structures or the attachment structures.

Key to *Dactylogyrus* species from Palaearctic fishes[10]

1 (2). The haptor lacks bars or has a thin poorly visible bar; marginal hooks are as long or longer than the anchors. The anchors are very small and very diverse in shape and dimensions of main part and roots; the anchors have very thin poorly visible wings; copulatory organ is of the "anchoratus" type.

D. yinwenyingae Gussev, 1962 (Fig. 7)

Syn.: *D. nasalis* Strelkow et Ha Ky, 1964; *D. osmanovi* Urasbaev, 1966; *Aplodiscus nasalis* Rogers, 1967

These small worms are up to 0.5 mm long and 0.12 mm wide. Length of marginal hooks is 0.023–0.029; anchors 0.015–0.025 mm (dorso-apical length; ventro-apical length is slightly larger); main part 0.014–0.021 mm, inner root 0.007–0.011 mm, outer root 0.004–0.008 mm; point 0.008–0.012 mm. The bar, if present, is 0.001 x 0.022–0.030 mm. Length of copulatory organ is 0.020–0.026 mm, tube diameter at initial part 0.005–0.007 mm and in middle 0.002 mm. Vaginal armament is not present.

Found in nasal cavities of many Cypriniformes (*Rutilus rutilus*, *R. r. lacustris*, *Scardinius erythrophthalmus*, *Leuciscus idus*, *Phoxinus phoxinus*, *Oreoleuciscus potanini*, *Blicca bjoerkna*, *Abramis brama*, *Aspius aspius*, *Chondrostoma nasus*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, and *Cyprinus carpio*); from the Danube River up to the Amur River; water reservoirs of North America.

It is found rarely, and no more than two specimens occur in one fish. Different forms that have been described previously as separate species seem to be only one species; the existence of the bar is at issue. Numerous materials from different localities and different fish species are needed to resolve this issue. The bar might form in the later stages of development when specimens are mature, which would explain why it was absent in some cases (*D. nasalis*). One marginal hook in a specimen from the Liao He River was shorter than the others, but this might be a deformity.

2 (1). The haptor has one or two bars; marginal hooks mostly are shorter than the anchors; anchors are stable in shape and wings are easily visible; the copulatory organ can be of different types.

3 (63). The haptor has one dorsal bar; the copulatory organ is of the "anchoratus" type in most cases.

4 (40). The anchors are of different types, but they are not "anchoratus" or "pseudanchoratus"; both roots are well developed; the rather wide inner root is up to five times longer than the outer one; the copulatory organ can be of the "anchoratus" type, or otherwise the accessory piece has a claw-shaped end and the tube of copulatory organ is spiral or thread-shaped.

[10] For species identification from fishes of the Amur region (*Ctenopharyngodon idella*, *Hypophthalmychthis molitrix*, *Aristichthys nobilis*, *Pseudorasbora*, *Pseudogobio*, and others) see Key to *Dactylogyrus* species from Amur River fishes.

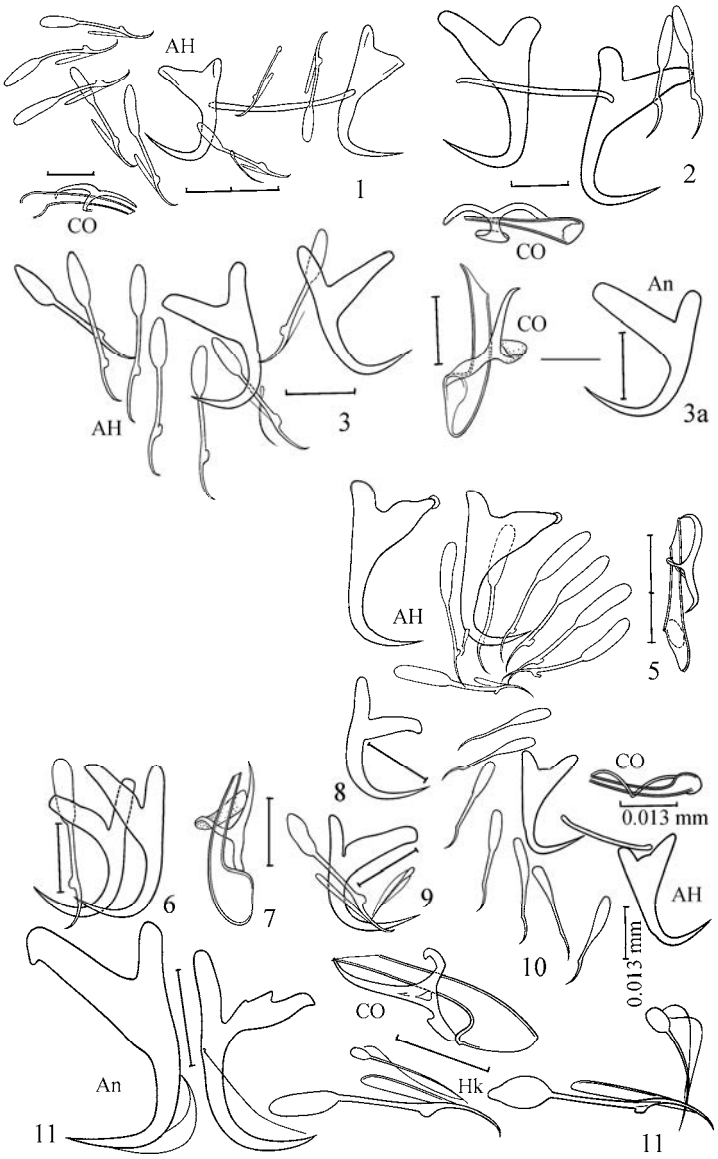


Fig. 7. *Dactylogyrus yinwenyingae* (after Gussev, 1985).

1 – specimen from ***Hypophthalmichthys molitrix***, Liao He River; 2 – specimen from ***Ctenopharyngodon idella***, Amur River; 3 - specimen from ***Chondrostoma nasus***, Tissa River; 3a – anchor variation, the same fish species and locality; 4 – specimen from ***Scardinius erythrophthalmus***, Latorica River (after Ergens, 1966); 5 - specimen from ***Ctenopharyngodon idella***, Yangtze River; 6 - specimen from ***Phoxinus phoxinus***, Tissa River; 7 - specimen from ***Rutilus rutilus***, Tissa River; 8 - specimen from ***Aspius aspius***, Tissa River; 9 - specimen from ***Abramis brama***, Tissa River; 10 - specimen from ***Cyprinus carpio***, Uzbekistan; 11 - specimen from ***Blicca bjoerkna***, Vrevo Lake (Leningrad region).

5 (10). The anchors have an open point that forms a unit-long blade with a shaft and a turned-in tip of the point ("falcatus" or "vastator" type of anchors).

6 (9). The tube of the copulatory organ is rather broad and has thin smooth walls; it is bent like a bracket; behind the broad funnel-shaped initial part, the tube is almost cylindrical up to its end, which is obliquely cut; vaginal armament is absent.

7 (8). The body is up to 1.6 mm long; the posterior end of the body before the haptor is peduncular (when the specimen sits on the gill filament, the haptor is surrounded by the host's tissues); the ratio of the anchors' ventro-apical length to length of the blade is 1.7–1.8; the bar usually is reinforced in the middle; the tube of the copulatory organ has a long posterior projection, which sometimes is longer than the length of the tube.
D. crassus Kulwiec, 1927 (Fig. 8, 9)

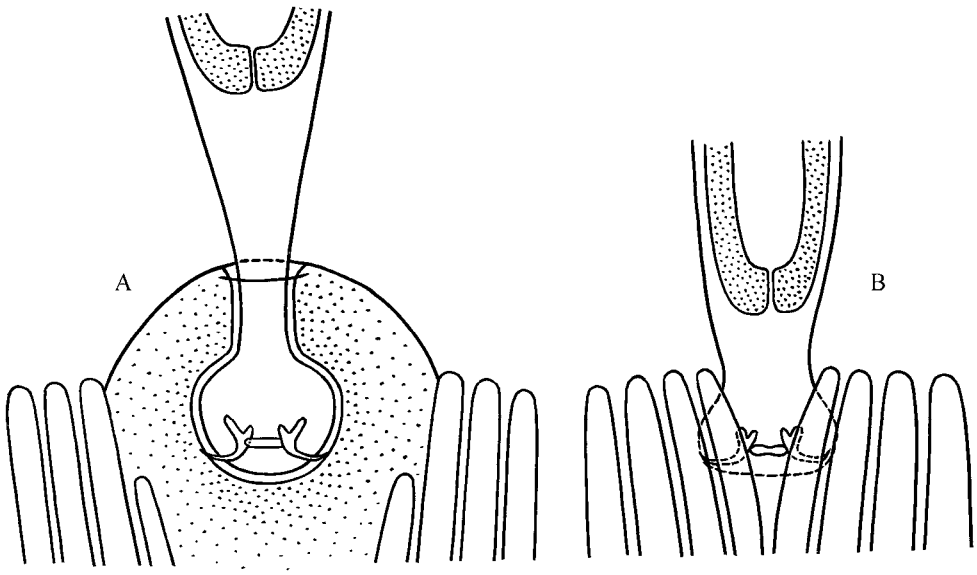


Fig. 8. Attachment manner of *Dactylogyrus crassus* (A) and *D. vastator* (B) to gills of *Carassius carassius*.

These are large worms, up to 1.6 mm long and 0.30 mm width. Length of marginal hooks is 0.029–0.048 mm; second pair is the most short (numeration: after Llewellyn, 1963). Length of anchors: dorso-apical 0.035–0.047 mm, ventro-apical 0.048–0.060 mm, inner root 0.017–0.025 mm, outer root 0.009–0.015 mm, blade 0.028–0.040 mm (its width at the level of the transition to the main part of the anchor is 0.0045–0.006 mm). Bar is 0.006–0.012 mm long in the middle and 0.008–0.012 mm long at its ends x 0.038–0.054 mm wide. Total length of the copulatory organ is 0.060–0.086 mm, tube (without projection) 0.025–0.035 mm (based on data from several authors); the original data list 0.075–0.130 mm for the copulatory organ and 0.045–0.060 mm for the tube, with a diameter in the middle part of 0.006–0.010 mm.

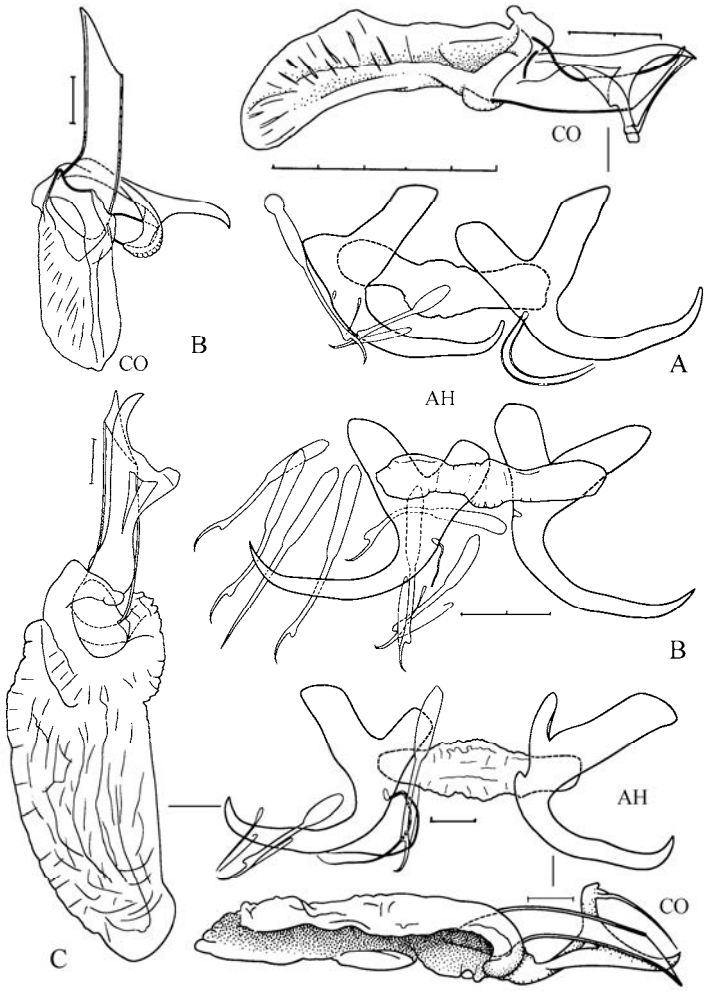


Fig. 9. - *Dactylogyrus crassus*.

A – specimen from *Carassius carassius;* Volga River, Rybinsk Reservoir, pond near Borok village (Russia); B – specimen from *Carassius carassius*; lower reach of Dnieper River near Kherson city (Ukrain); C – specimen from *Carassius auratus*; Volgograd Reservoir, Volga River (Russia).

Found on gills of *Carassius carassius*; Dniestr, Dnieper, Volga, Ob', and Yenisey Rivers; ponds of Old Peterhof near St. Petersburg (Russia); Nura River (Kazakhstan); water bodies of Poland, Czechia, and Germany. In the Volga Delta and Ob' (Russia) and Turgay (Kazakhstan) Rivers, found also on *C. auratus gibelio*. Kollmann (1968) reported *D. crassus* on young carps of 12 cm length. Other data are doubtful and need verification.

In the past the validity of this species semed doubtful, as there was no differential diagnosis to separate it from *D. vastator*, although Kulwiec (1927) was right in noting its main features. In addition, some living specimens were studied from the Rybinsk Reservoir and Peterhof Ponds (Rus-

sia). Besides the features mentioned in thesis 7(9) and seen in Fig. 9, there is a swelling on the handle of the marginal hooks in *D. vastator* that is absent in *D. crassus*; moreover, the handle is shorter in *D. crassus* compared with that of *D. vastator* (Kulemina, 1976). Nevertheless, the problem with this identification is not yet solved. The stalk is formed after the haptor of *D. crassus* is overgrown with the host's gill tissue and all features are not easily visible in young specimens. Some specimens that can be identified as *D. crassus* using the shape of the anchors and bar can be identified as *D. vastator* using the structure of the copulatory organ, which lacks a long projection of the tube (seen the figure published in Kollmann (1968)). Difficulties in identification also occur because the anchors of these two species are rather variable; particularly variable is the shape of the roots. To date, it is not clear if *Cyprinus carpio* is a host of *D. crassus*; Kollmann is the only researcher ever to have has described it from the gills of this carp.

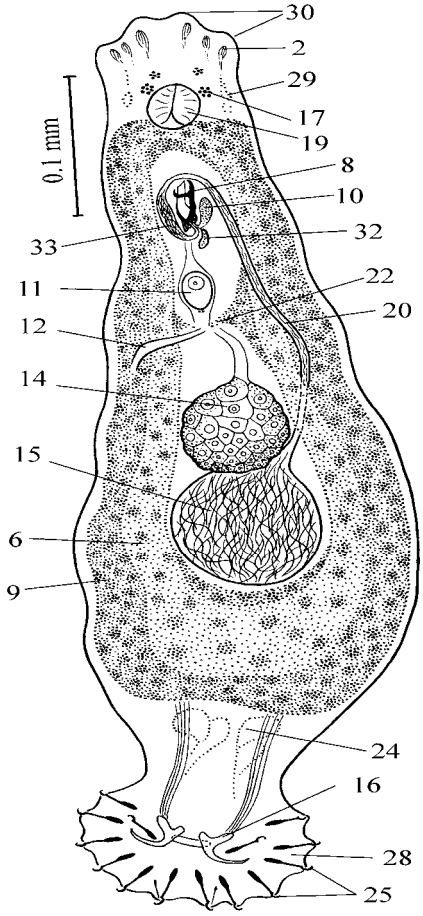


Fig. 10. - Scheme of *Dactylogyrus vastator* morphological structure (after Gussev, 1985). Ventral view. Designations are the same as on Fig. 1.

8 (7). Body length is up to 1.2 mm; there is no stalk before the haptor; the haptor is not immersed into gill tissues but lies between the gill filaments. Ratio of length of anchor to blade is 1.48–1.58[11]; the bar is slightly thickened at its ends; the copulatory tube has a small posterior projection.

D. vastator Nybelin, 1924 (Fig. 8, 10, 11)

Syn.: *D. megastoma* Wagener, 1857 ? (see Supplement); *D. laymani* Schpolanskaja, 1949

These are large worms, up to 1.25 mm long and 0.25 mm wide. Length of marginal hooks is 0.025–0.045 mm; the second pair is shortest. Length of anchors: dorso-apical 0.036–0.045 mm, ventro-apical 0.049–0.063 mm, inner root 0.016–0.025 mm, outer root 0.009–0.015 mm, blade 0.034–0.040 mm (its thickness is 0.0033–0.005 mm). The bar in the middle is 0.005–0.009 mm and at the ends is 0.006–0.012 x 0.035–0.044 mm. Total length of the copulatory organ is 0.040–0.069 mm, tube 0.025–0.046 mm (its diameter is 0.003–0.008 mm).

Found on gill filaments of *Carassius carassius*, *C. auratus gibelio*, *Cyprinus carpio* (both wild and domesticated), *Cyprinus carpio rubrofuscus*, and *Phoxinus percnurus* (?)[12]; widespread in Palaearctic and Amur regions.

Specimens from *Carassius* and *Cyprinus carpio* exhibit some differences in size of the chitinoid structures. These structures are smaller in specimens from carp and young *Carassius*; this is especially true for the size of the copulatory organ, ventro-apical length of the anchors, thickness of their blades, length of the marginal hooks, and bar size.

[11] For specimens from mature fishes. This index from specimens found on young fishes is 1.41–1.48 (Kulemina, 1976).

[12] Kastak (1956) found it on *Vimba vimba*, but this report seems to be an error or a solitary case. Kulemina (1977) found mature *D. vastator* on the fins of *Carassius carassius* m. humilis fingerling in little closed ponds of Peterhof near St. Petersburg.

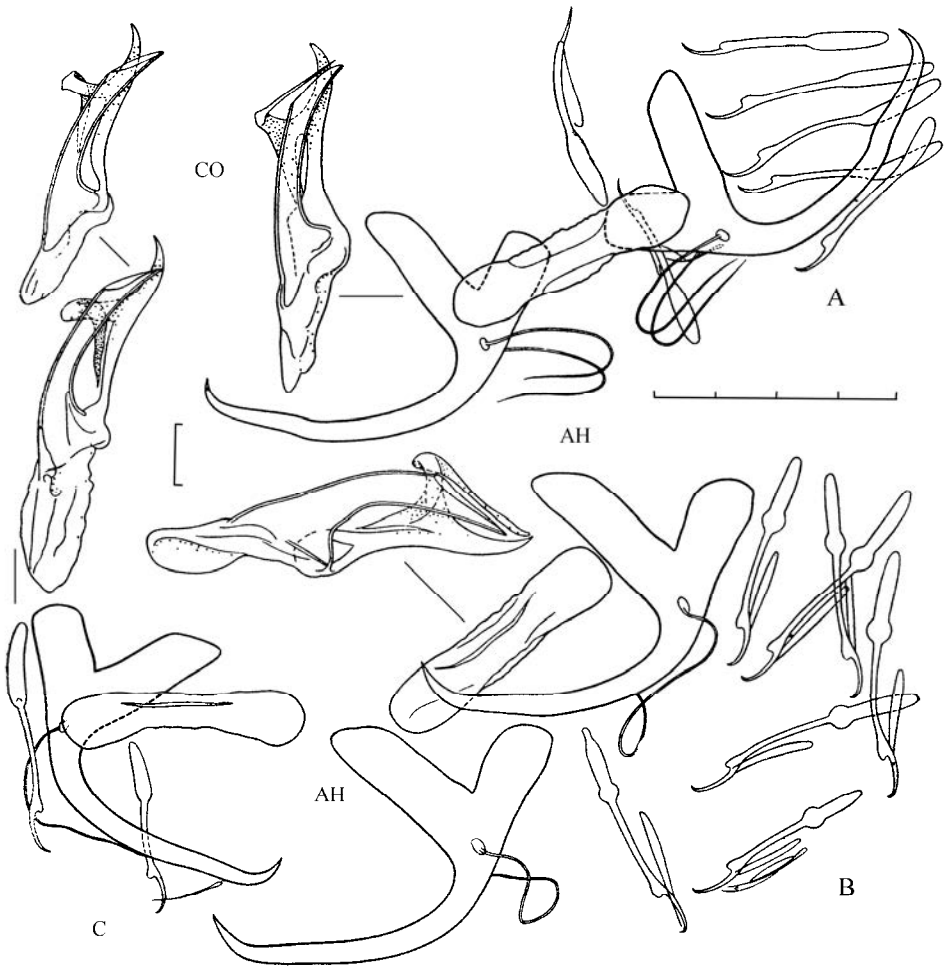


Fig. 11. *Dactylogyrus vastator*.

A – specimen from *Carassius carassius*; Volgograd Reservoir, Volga River (Russia); B - specimen from *Carassius auratus*; Volga River, Rybinsk Reservoir, pond near Borok village (Russia); C – specimen from *Cyprinus carpio* (0+); ponds of the Bryansk region (Russia).

D. vastator infects mainly 2–5 cm long fingerlings, often resulting in mortality of the host. Uspenskaya (1961) reported that 20–40 parasites can kill 50–200 mg, 2 cm long fish; 60–80 specimens can kill 200–300 mg, 2.5 cm long fish; and 140–160 specimens can kill 750 mg, 3.5–4.0 cm long fish. Infection decreases with age of the fish.

In most cases, *D. vastator* is found near the tips of the gill filaments. Highly infected gills are covered with mucus, and haemorrhaging and necrosis of the gills can be observed. Parasites move to the tips of filaments, causing degeneration and connective tissue overgrowth in surviving fishes. Sometimes, adhesions of adjacent gill filaments can be observed; these modified filaments can tear away with parasite intact, and the gill tissues may be restored. Mortality in the host often is observed in carp farms situated in southern regions (e.g., Ukraine, Kazakhstan, Georgia). In the northern regions, *D. vastator* infection is not so dangerous because the optimal temperature for its

development is 22–24 ºC. Such temperatures occur often in the southern regions in June and July when fingerlings reach a length of 2–5 cm. Decreased temperatures depress development of the parasite. The time needed for egg development and larval life increases, whereas the growth of the parasite and egg production become slower. Thus, the infection rate decreases with the colder temperatures of autumn. *D. vastator* is seldom found in winter, which makes sense because at this time fish do not feed on plankton but live near the bottom feeding on benthic organisms, wherease parasite larvae remain near the surface. Nevertheless, the main reason for this decrease in autumn/winter is superinfection immunity (Paperna, 1964b; Vladimirov, 1971); immunity begins to occur after high infection with the first generation of *D. vastator*.

Factors such as sunlight decrease the life span of swimming *D. vastator* larvae. However, *D. vastator* does not seem to be affected by low oxygen content; when the oxygen content is very low and fish begins to perish, the parasite survives and increases egg production.

Mortality of fishes takes place when stock abundance is very high and food quality is bad. This scenario decreases fish growth and increases the period during which *D. vastator* is dangerous. Decreased water temperature also depresses fish growth. When the temperature increases again, *D. vastator* infection also increases.

Methods of controlling *D. vastator* infection include decreasing stock abundance; removing spawners as soon as spawning is over; not stocking ponds containing one summer old carps with older carps; and optimal feeding. If mortality begins, one summer old carps need to be moved to other ponds where stock density is not high. This prevents secondary infection. Ponds in which one summer old carps are cultured should not to be supplied with water from ponds in which older fish's spawners are reared. All small ponds should be covered with lime before filling with water to kill *D. vastator* eggs that were left there from the preceding summer. Moreover, water temperature of the ponds should be maintained at ~20 º C for at least 6 days before stocking. During this period, any larvae present should hatch and perish. Use of an ammonia bath (1 ml of 25% ammonia solution per liter of water for 30 seconds) or treatment with copper-ammonia $(NH_4)CuSO_4$ (~0.1–0.2 mg/l) are other potential control methods. Treatment must be performed 3–4 times with an interval 48 hours. Good results also have been obtained with trichlorfon and some of its analogues as well as other substances containing phosphorus (25 ppm solution for 24 hours).

The following literature discusses control methods for this parasite: Wunder (1929); Bychowsky (1933a); Agapova (1948); Bauer et Nikolskaya (1951); Layman (1951b,1955); Izumova (1953, 1956, 1958); Bauer (1954, 1959); Uspenskaya (1961); Paperna (1963a, 1963b, 1964b); Sarig (1965); Kollman (1970); Vladimirov (1971); Vaniatinski et al. (1979); Schaeperclaus (1979, 1992); and Bauer et al. (1981).

9 (6). The tube of the copulatory organ is rather thin and wavy but has thick walls; a corkscrew-shaped crest is visible on its surface; and the tube becomes narrower at its end. Vaginal armament is present.

D. achmerovi Gussev, 1955 (Fig. 12)

These are small worms, 0.40 mm long and up to 0.11 mm wide. Length of marginal hooks is 0.021–0.030 mm. Total length of anchors is 0.043–0.058 mm, with the main part 0.043–0.051 mm, inner root 0.010–0.018 mm, and outer root 0.004–0.006 mm. Dorso-apical and ventro-apical length are nearly equal, with the latter slightly longer. Bar size is 0.004–0.006 x 0.029–0.033 mm. Total length of the copulatory organ is 0.052–0.058 mm, and the vaginal armament is like scyphiform.

Found on gill filaments of *Cyprinus carpio* and *C. c. rubrofuscus*; in many water bodies of the Palaearctic and Amur regions. This species may have been transferred to carp farms of the Palaearctic region with *C. c. rubrofuscus*. Currently this species occurs in natural waters (e.g., in the Dniepr River Basin).

10 (5). The anchors have a point that forms an acute or right angle with the shaft of the anchors' main part.

11 (17). The third pair of marginal hooks are 1.5–2 times longer and more massive than the others; their shape also differs from that of the others. The anchors have large roots, and the inner root is longer than the main part (anchors and haptor have the "sphyrna" type).

12 (13). The third pair of marginal hooks is twice as long as the others. The copulatory organ tube is curved into a spiral with 2.5 spires; it is more than 0.10 mm long, and the diameter of the middle part is about 0.002 mm; vaginal armament is present.
D. sphyrna Linstow, 1878 (Fig. 13)

These are large worms, up to 1.4 mm long and up to 0.2 mm wide. The third pair of marginal hooks are 0.034–0.052 mm long; the others are 0.015–0.028 mm long. Total length of anchors is 0.047–0.070 (0.042–0.047 mm for specimens from *Blicca bjoerkna* 1+), with the main part 0.022–0.030 mm, inner root 0.030–0.050 mm, outer root 0.010–0.015 mm, point 0.011–0.015 mm. Bar size is 0.005–0.008 x 0.021–0.034 mm. Total length of the copulatory organ is 0.045–0.050, with the tube up to 0.135 mm long. Length of the vaginal tube, which is very slender and poorly visible, is 0.030–0.050 mm, with a diameter of 0.003–0.004 mm.

Found on gill filaments of *Blicca bjoerkna* (main host), *Rutilus rutilus*, *R. r. aralensis*, *R. r. lacustris*, *R. frisii kutum*, *Abramis brama*, *Vimba vimba*, and *Squalius cephalus*[13]; Ibragimov (1977) and Spiranti (personal communication) reported high infection of *Rhodeus amarus* in Transcaucasus water bodies. This infection of fishes not related to the main host occurs at the border of the main host's area of distribution. Found in the basins of the Baltic, Black, Caspian, Aral, and White (River Sukhona) Seas; water bodies of Siberia (Ob', Yenisey, and Lena Rivers); Nura River (Kazakhstan); Great Britain; France. It was also found in Israel on gills of *Acanthobrama terraesanctae*.

13 (12). The third pair of marginal hooks is 1.5 time longer than the others. The copulatory organ tube is curved just after the bladder-shaped anterior part; its length is less than 0.10 mm and the diameter at the middle is 0.001–0.005 mm. Vaginal armament may be present or absent.

14 (15). The copulatory organ tube is broad, with a diameter at the middle part of about 0.005 mm. Vaginal armament is absent.
D. similis Wegener, 1910 (Fig. 14)

These worms are medium or large in size, up to 1.2 mm long and 0.2 mm wide. The third pair of marginal hooks is 0.030–0.040 mm long, whereas the others are 0.016–0.024 mm. Length of anchors is 0.038–0.054 mm, with the main part 0.023–0.027 mm (after Prost (1957) up to 0.034 mm), inner root 0.026–0.035 mm, outer root 0.009–0.012 mm, point 0.009–0.013 mm. Bar size is 0.005–0.008 x 0.022–0.028 mm. Length of the copulatory organ is 0.052–0.067 mm.

Found on gill filaments of *Rutilus rutilus*, *R. r. lacustris*, and rarely on *Blicca bjoerkna*[14]; Basins of the Caspian, Black, Baltic, and White (Sukhona River) Seas; Pechora, Ob', Yenisey, and Selenga Rivers; Czechia; England; and France.

15 (14). The tube of the copulatory organ is very thin, with a diameter of about 0.001 mm. Vaginal armament is short and dumb-bell shaped.

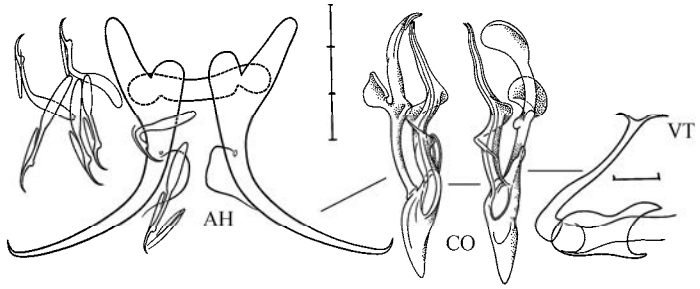
[13] There are data reporting the present of *D. sphyrna* on *Aspius aspius* and *Scardinius erythrophthalmus* (Kastak, 1956; Shevchenko, 1956; Moravec, 2001) as well as on *Chondrostoma nasus*, *Leuciscus idus*, and *L. leuciscus* (Moravec, 2001). These likely are the result of accidental occurrences on unusual hosts.
[14] Radulescu et Vasiliu (1955) found this species on the gill filaments of *Scardinius erythrophthalmus*, Kastak (1956) on *Vimba vimba*, Mariz (1957) on *Abramis brama* and *Ballerus sapa* from the Prut River, and Agapova (1960) on *Leuciscus idus* from the Ubagan River (Kazakhstan). Other doubtful reports indicate its presence on the gill filaments of *Tinca tinca*, *Alburnus alburnus*, *Chondrostoma nasus*, *Squalius cephalus*, *Leuciscus leuciscus*, and *Aspius aspius*.

D. vistulae Prost 1957 (Fig. 15)
Syn.: *D. similis* in: Markewitsch, 1951 part.

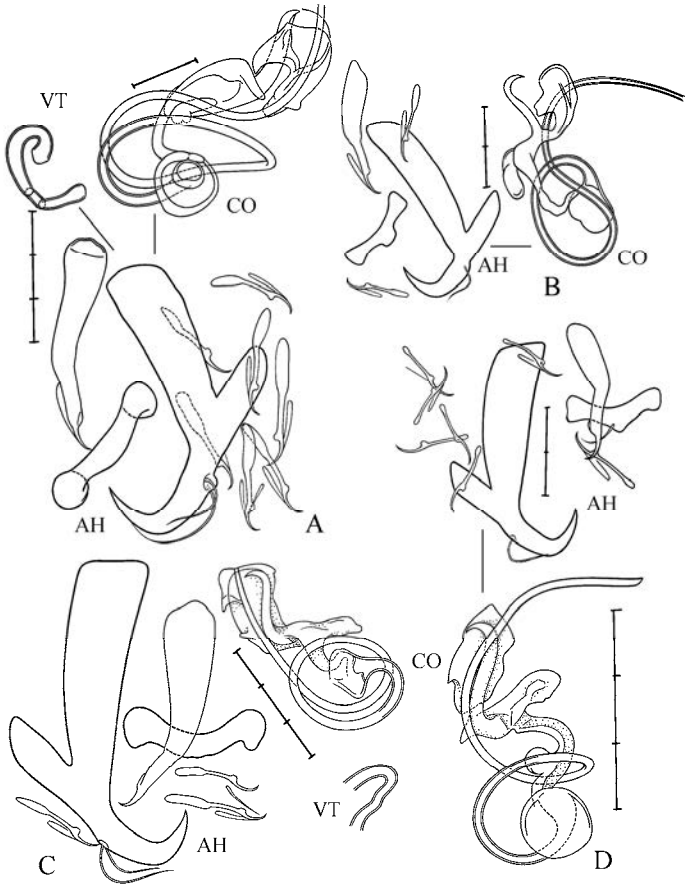
These worms are medium or even large in size, up to 1.25 mm long and 0.26 mm wide. Length of third pair of marginal hooks is 0.032–0.042 mm, whereas the others are 0.018–0.024 mm. Length of anchors is 0.053–0.061 mm, main part 0.022–0.026 mm, inner root 0.036–0.044 mm, outer root 0.012–0.017 mm, point 0.010–0.011 mm. Bar size is 0.004–0.006 mm (in the middle part) x 0.021–0.026 mm. Length of the copulatory organ is 0.060–0.072 mm. The vaginal armament is 0.030–0.040, with a diameter of about 0.015 mm.

Found on gills of *Squalius cephalus*, *Chondrostoma nasus*, *Ch. oxyrhynchum*, and very infrequently on *Rutilus rutilus* and *R. r. lacustris*. Data on the occurrence of this species on *Leuciscus leuciscus*, *Alburnus alburnus*, and *Aspius aspius* are doubtful; likely these reports are the result of accidental occurrence or an error in identification (it is very similar to *D. similis*). Found in the rivers of the Black and Baltic Sea basins and the Ob' and Selenga Rivers in Siberia. It has been found in France on *Squalius cephalus*, *L. leuciscus*, and *Chondrostoma nasus* and in Czechia and Slovakia on 11 fish species (Moravec, 2001) (see host–parasite list).

16 (17). The width of the copulatory organ tube is 0.002–0.003 mm. Vaginal armament is absent.
D. polylepidis Alvarez-Pellitero et al., 1981 (Fig. 16)



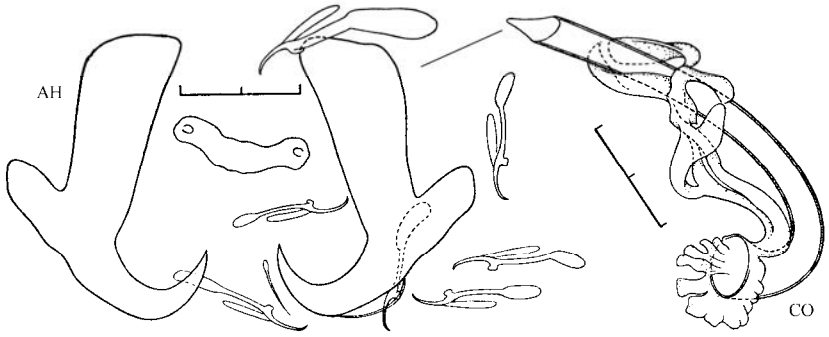
12



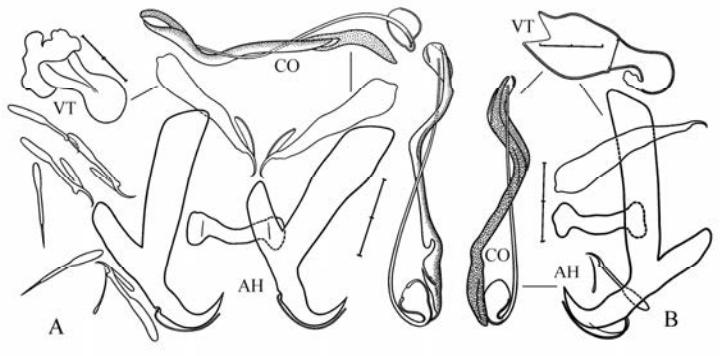
13

Fig. 12 – 13.

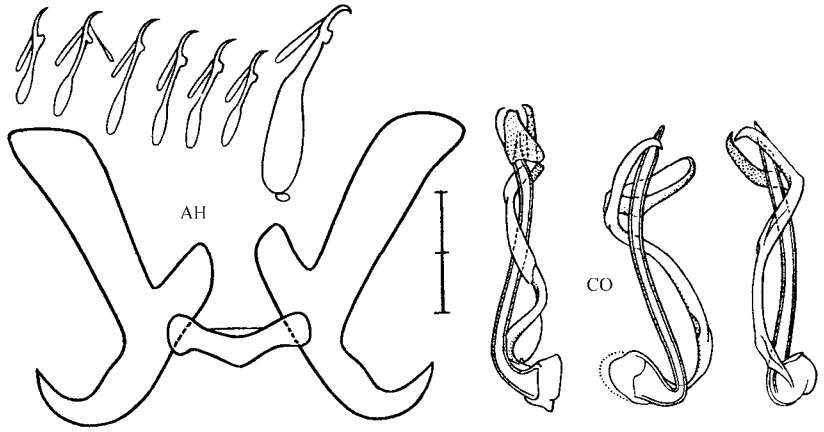
12 - *Dactylogyrus achmerowi*. Specimen from *Cyprinus carpio*; Valday fish farm, Novgorod region (Russia); vt – specimen from pond near Borok village (Russia). **13 -** *Dactylogyrus sphyrna.* A – specimen from *Rutilus rutilus*, UK; B – specimen from *Rhodeus amarus*, Rioni River, (Georgia); C – specimen from adult *Blicca bjoerkna*, Iriklinskoye Reservoir, Volga River (Russia); D - specimen from *Blicca bjoerkna (*1+), Lake Seliger, Volga River (Russia).



14



15



16

Fig. 14 – 16.
14 – *Dactylogyrus similis* from *Rutilus rutilus*, Lake Vrevo, Leningrad region (Russia). **15 -** *Dactylogyrus vistulae*. A – specimen from *Squalius cephalus*, Elbe River (Czechia), B - specimen from *Chondrostoma nasus*, Latorica River (Czechia). **16 -** *Dactylogyrus polylepidis*; specimen from Spain (after Alvarez-Pellitero et al., 1981).

These are relatively large worms, with body length 0.955–1.52 (average 1.22) mm and width 0.2–0.3 (0.24) mm. Marginal hooks of the seventh pair are bigger than the rest of the pairs. Marginal hook length measurements are as follows: pair I: 0.015–0.020 (0.018) mm, handle 0.005–0.007 (0.006) mm; II: 0.016–0.021 (0.019) mm, handle 0.005–0.009 (0.007) mm; III: 0.017–0.021 (0.020) mm, handle 0.006–0.008 (0.007) mm; IV: 0.017–0.021 (0.020) mm, handle 0.006–0.008 (0.007) mm; V: 0.016-0.020 (0.019), handle 0.005-0.007 (0.006); VI: 0.016–0.020 (0.017) mm, handle 0.005–0.008 (0.006) mm; VII: total length 0.029–0.034 (0.032) mm, handle 0.014–0.020 (0.018) mm. Length of anchors is 0.043–0.051 (0.049) mm, main part 0.017–0.025 (0.023) mm, outer root 0.009–0.012 (0.011) mm, inner root 0.031–0.035 (0.033) mm, point 0.010–0.015 (0.013) mm. Size of dorsal bar is 0.022–0.029 (0.025) x 0.005-0.007 (0.006) mm. Ventral bar is absent. Length of the copulatory organ is 0.037–0.052 (0.048) mm. Vaginal armament is absent.

Found on gills of *Chondrostoma polylepis* and *Squalius cephalus*; Spain.

17 (11). The marginal hooks are of the same shape and have a little difference in length. The anchors have moderately developed roots; sometimes they are rather long, but the inner root is shorter than the main part.

D. editus Djalilov, 1976 (Fig. 17)

The length of the marginal hooks is 0.025–0.035 mm. Total length of anchors is 0.029–0.033 mm, main part 0.018–0.020 mm, inner root 0.013–0.018 mm, outer root 0.008–0.011 mm, point 0.012–0.015 mm. Size of the rather massive dorsal bar is 0.004–0.006 x 0.021–0.030 mm (ratio of length to width is 1:5.5–1:6). Total length of the copulatory organ is 0.048–0.068 mm. Vaginal armament is bubble-shaped with a short tube of diameter 0.036–0.040 mm.

Found in nasal cavities of *Schizopygopsis stoliczkai* from the Pyandzh River (Tajikistan).

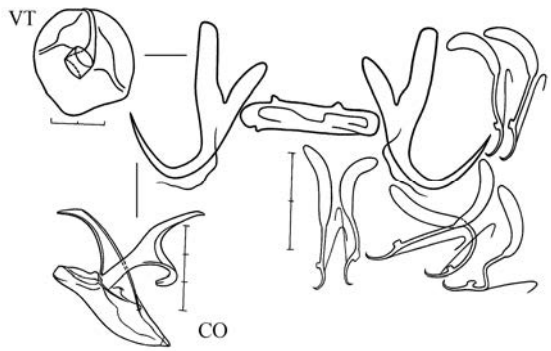


Fig. 17. *Dactylogyrus editus* (after Dzhalilov, 1976).

18 (19). The copulatory tube makes a loop, is thread-like (diameter of the middle part is less than 0.001 mm), and is very long (up to 0.55 mm along the curve). It extends the length of the whole worm. The initial part of the tube is in the shape of a "mirror with a handle." The vaginal armament is of similar length and rolled into a ball.

D. auriculatus (Nordmann, 1832) (Fig. 18)

These medium-sized worms are up to 0.7 mm long and 0.12 mm wide. Length of marginal hooks is 0.021–0.033 (0.016–0.023) mm,[15] anchors 0.056–0.072 (0.029–0.037) mm (in some cases up to 0.080), with the main part 0.043–0.050 (0.025–0.031) mm, inner root 0.019–0.025 (0.009–

[15] Size of chitinoid structures of specimens gathered from young *Abramis brama* (0+) given in brackets, those from older breams (6+ - 13+) given without brackets.

0.012) mm, outer root 0.003–0.006 (0.002–0.004) mm, point 0.017–0.024 (0.010–0.014) mm. Bar size is 0.008–0.010 x 0.024–0.031 (0.004–0.005 x 0.015–0.019) mm. Total length of the copulatory organ is 0.122–0.238 (0.082–0.136) mm. Diameter of the vaginal spiral is 0.020–0.039 (0.023–0.027) mm.

Found on gills of *Abramis brama* and *A. b. orientalis*. Presence on other fishes seem to be accidental; basins of the Baltic, Black, Caspian, and Aral Seas; water bodies of southern France. Specimens from younger and older fish differ in their measurements of chitinoid structures and in the shape and indices of the parts of these structure (this is especially true for marginal hooks, anchors, and bars; see Fig. 18). The range of monogenean variability as related to fish age and size is the greatest in this species among the ~20 species studied (Gussev, 1985).

19 (20). The copulatory organ structure is the same as for *D. auriculatus*, but the vaginal armament is not rolled into a ball and the total anchor length is less than that of *D. auriculatus* from adult fishes.

D. ivanovichi Ergens, 1970 (Fig. 19)

Length of marginal hooks is 0.013–0.018 mm. Total length of anchors is 0.045–0.050 (at the average 0.045) mm, main part 0.032–0.036 (0.032) mm, outer root 0.002–0.003 (0.002) mm, inner root 0.019–0.022 (0.019) mm, point 0.015–0.017 (0.015) mm. Size of dorsal bar is 0.003–0.005 x 0.021–0.026 (0.004 x 0.021) mm. Total length of the copulatory organ is about 0.055 mm. Vaginal tube is about 0.10 mm long.

Found on gills of *Pachychilon pictum*; Lake Skadar, former Yugoslavia.

20 (21**)**. The tube of the copulatory organ is spirally twisted, and bent into a sickle shape or nearly straight; its length is less than 0.290 mm; initial part has another shape than *D. auriculatus* and *D. ivanovichi*. If present, the vaginal armament is a bent tube (length up to 0.15 mm) or a bubble with a short tube.

21 (24). The tube of the copulatory organ is twisted into a broad spiral which has 1.5 turns; its length is not less than 0.170 mm; its accessory piece is claw shaped at its end. Vaginal armament is a long bent tube. The intestinal trunks are not confluent posteriorly.

22 (23). The point of the massive anchors smoothly passes into the main part. Length of the copulatory organ is about 0.090 mm, and the tube more than 0.24 mm.

D. robustus Malewitzkaja, 1941 (Fig. 20)

These large worms can be up to 1.4 long mm and 0.4 mm wide. Length of marginal hooks is 0.037–0.041 (0.026-0.039 after Malewitzkaja, 1941) mm. Dorso-apical anchor length is 0.050–0.053 (0.045–0.048) mm, ventro-apical 0.067–0.073 mm, main part 0.039–0.045 mm, inner root 0.023–0.025 (0.029) mm, outer root 0.018–0.020 (0.016–0.019) mm, point 0.033–0.035 (because it is not sharply limited, we give the length of the blade as 0.042–0.046) mm. Size of the very massive bar is 0.018–0.020 x 0.074–0.087 mm. Total length of the copulatory organ is about 0.090 mm and the tube along the curve is 0.22–0.24 long. The vaginal tube is 0.13–0.156 mm long.

Found on gill filaments of *Leuciscus idus*, *L. waleckii*, and *Aspius aspius* (?) from many European rivers and the Amur River.

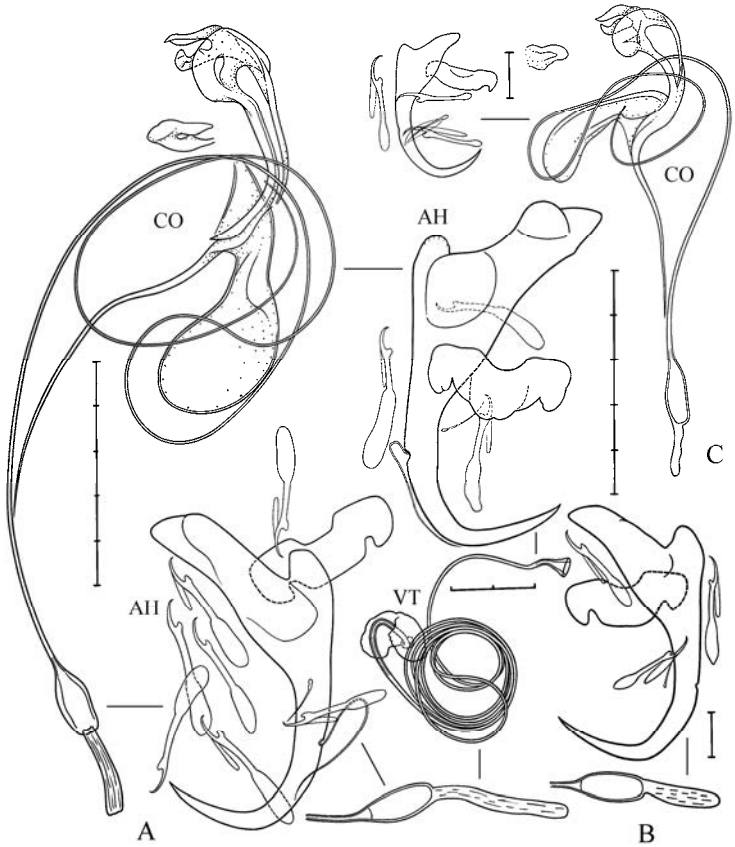


Fig. 18. - *Dactylogyrus auricalatus.*

A – specimen from *Abramis brama* (13+), B - specimen from *Abramis brama* (6+), C - specimen from fry of *Abramis brama* (0+); Volga River, Rybinsk Reservoir, near Borok village (Russia).

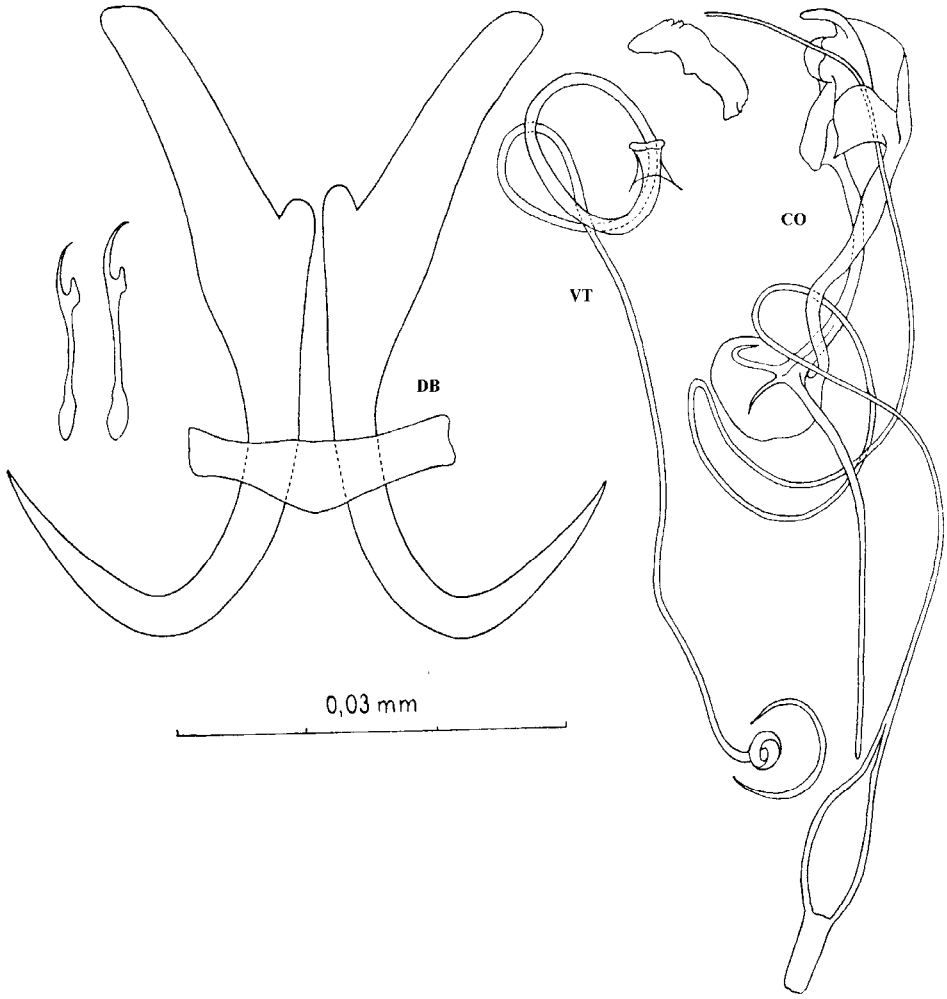


Fig. 19. - *Dactylogyrus ivanovichi* (after Ergens, 1970).

23 (22). The point of the thinner anchor passes into the main part with a sharp twist. Length of the copulatory organ is less than 0.070 mm, and length of the tube is less than 0.19 mm.
D. fallax Wagener, 1857 (Fig. 21)

These are large worms, up to 1.0 mm long and 0.3 mm wide. Length of marginal hooks is 0.037–0.043 mm. Dorso-apical anchor length is 0.045–0.062 mm, ventro-apical 0.050–0.067 mm, main part 0.040–0.44 mm, inner root 0.023–0.027 mm, outer root 0.015–0.018 mm, point 0.015–0.018 mm. Bar size is 0.010-0.013 x 0.045–0.059 mm. Total length of the copulatory organ is 0.050–0.070, and the tube is 0.16–0.17 mm long. Length of the vaginal tube is 0.085–0.093 mm.

Found on gill filaments of *Rutilus rutilus*, *Blicca bjoerkna*, *Alburnus alburunus*, *Leuciscus idus*, *Squalius cephalus*, *Scardinius erythrophthalmus* (?), and *Leuciscus leuciscus* (?); water bodies of the Black, Baltic, and Caspian Sea basins.

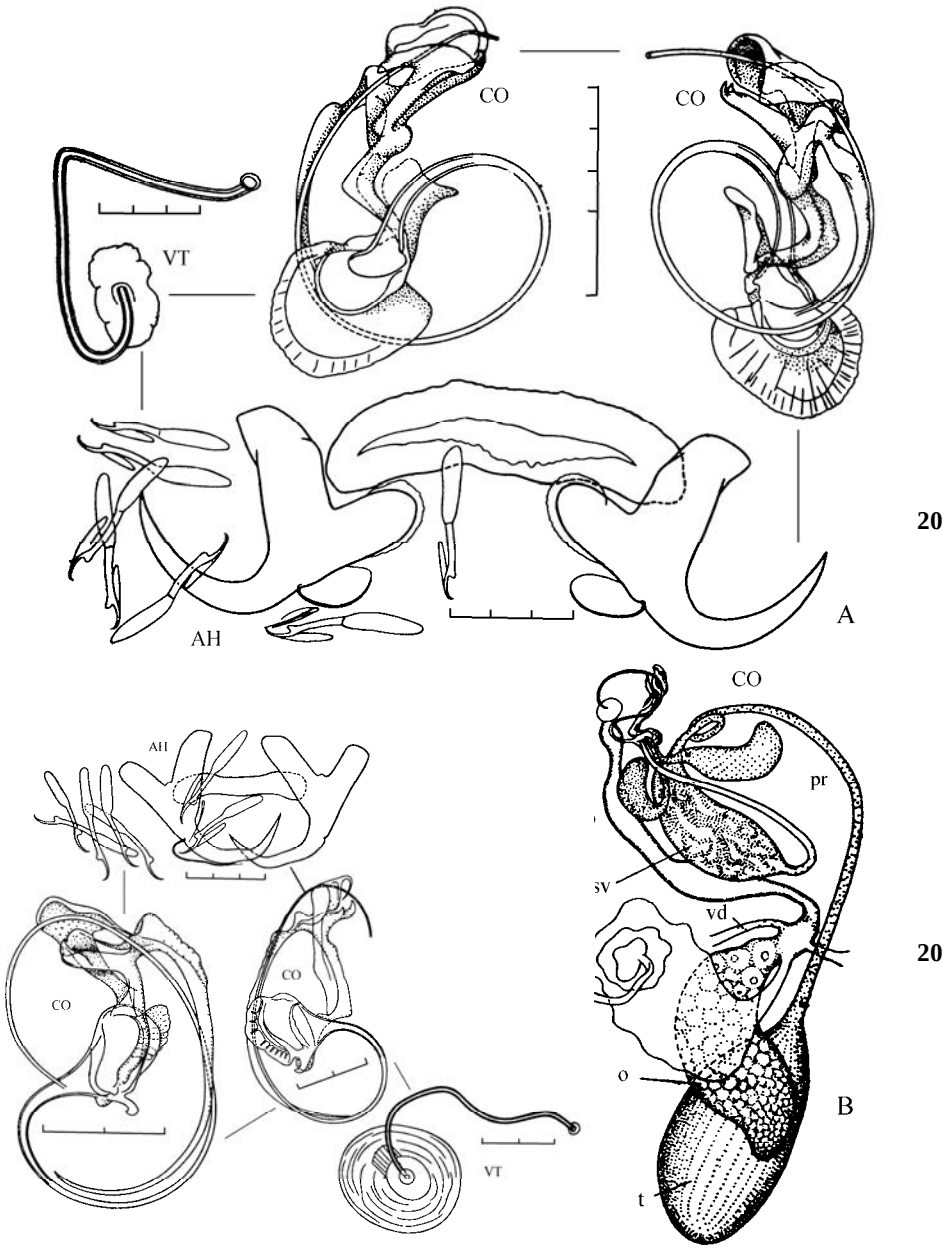


Fig. 20 – 21.
20 - *Dactylogyrus robustus* from Lake Khanka (Russia) (after Gussev, 1955a). A – chitinoid structures, B – scheme of genital organs morphological structure (co – copulatory organ, oo – ootype, o – ovary, pr – reservoirs of prostatic glands, t – testis, v – vaginal tube and seminal receptacle, v – vitellaria duct, sv - seminal vesicle. **21 -** *Dactylogyrus fallax*, Severskiy Donets River (Russia, Ukraine).

24 (21). The tube of the copulatory organ is nearly straight, sickle shaped, or bent like the Greek letter **Γ**; its length is less than 0.105 mm; the accessory piece can be of different types. Vaginal armament is absent, or, if present, is a bubble-shaped formation. The intestinal trunks usually are confluent posteriorly.

25 (28). Total length of the anchors is greater than 0.060 mm. The tube of the copulatory organ is bent.

26 (27). The tube of the copulatory organ is bent like the Greek letter **Γ**; its length is greater than 0.070 mm; the accessory piece is like a simple straight plate with a spade-shaped expansion at the end ("extensus" type). This is parasite of *Cyprinus carpio* (both wild and domesticated).
D. extensus Mueller et Van Cleave, 1932 (Fig. 22, 23)
Syn.: *D. solidus* Achmerow, 1948; *D. hovorkai* Kastak, 1957

These large worms can be up to 1.5 mm long and 0.31 mm wide. Length of marginal hooks is 0.022–0.038 mm. Anchor length: dorso-apical 0.062–0.089 mm, ventro-apical slightly larger; main part 0.056–0.078 mm, inner root 0.020–0.032 mm, outer root 0.011–0.019 mm, point 0.017–0.020 mm.[16] Length of bar is 0.008–0.019 x 0.040–0.059 mm. Length of copulatory organ is 0.068–0.085 mm, diameter of tube 0.005–0.006 mm in its middle part. Vaginal armament is absent.

Found on gill filaments of *Cyprinus carpio*, *C. c. rubrofuscus*, and *Misgurnus fossilis* (?).[17] *D. extensus* is widely distributed in Europe, Asia, and North America. It was brought to N. America from West Germany in the 1970s with mirror carp, but in western Europe was found only after World War II (Danube and Volga Rivers and later everywhere). It is unknown why this large species was not found by A. Nordmann, G. Wagener, and other specialists who described many species of *Dactylogyrus* from Central Europe. Surely it was present, but perhaps it was very rare.

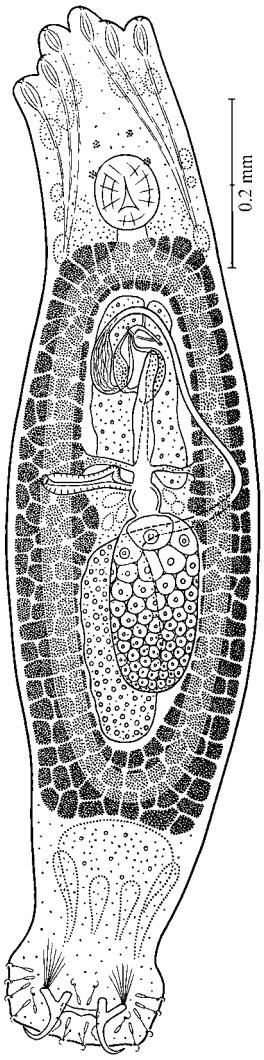
D. extensus seems to be regional inhabitant of the basins of the Black, Caspian, and Aral Seas before wild Amur carp were introduced there; bad control over fish transportation likely was the chief reason that it became established in most fish farms.

D. extensus is a pathogen within carp farms. It attaches to the middle part of the gill filaments, and the epithelial monolayer of the filaments becomes a multi-layer one; many cells then become transformed into mucous cells. The mucus covers the gills and causes the fish to have trouble with respiration. Infection with *D. extensus* has caused mortality of one-summer-old fish and of highly infected specimens of older ages, including spawners, especially in the northwestern provinces of Russia and the Baltic republics. One-summer-old carps that were 4–4.5 cm long perished in experiments in which they carried a burden of 25–30 specimens of *D. extensus*.

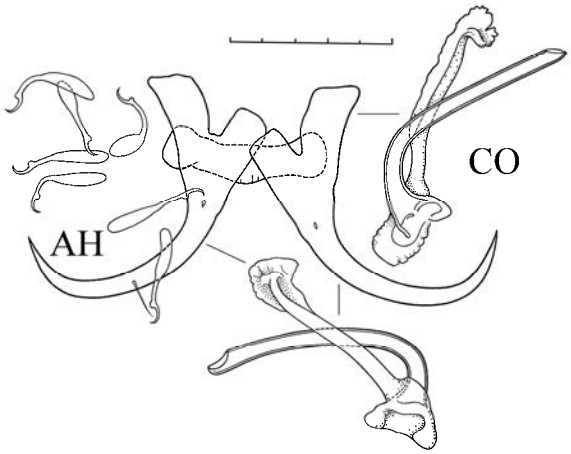
The optimal temperature for *D. extensus* is rather low, about 13–15 ºC, and they require a high oxygen concentration. Oxygen deficiency and temperature over 20 ºC depress parasite activity; in such conditions they migrate to the end of filaments and produce many eggs, but the eggs are eliminated. Sunlight shortens the life span of swimming larvae, as is the case with *D. vastator*. If we compare *D. extensus* with *D. vastator*, the first prefers lower temperature and running water; it is rather dangerous in northern regions of carp rearing (more dangerous than in southern regions, where its population decreases during the mild sunny summer months). If the young carps do not perish, then high infection with *D. extensus* reduces carp growth rate.

[16] Ergens et Lom (1970) gave the length as 0.029 mm, whereas Chen et al. (1973) reported 0.009–0.019 mm.
[17] Radulescu et Vasiliu (1955) reported that *Carassius auratus gibelio* is also its host, but in natural conditions it has been found only on wild carp. In experiments *D. extensus* lives rather a long time on *C. carassius*. Vincente et al. (1975) found it on *C. carassius* in Spain, which seems to be doubtful or is an occasional case.

D. extensus infection increases during fish growth whereas *D. vastator* infection decreases. This difference can be explained in such a way: *D. extensus* larvae live near the bottom in the cooler water layers and rarely have contact with carp larvae, which prefer to inhabit the upper layers because they eat plankton. Only when carps began to feed on benthic animals do conditions favourable for infection with *D. extensus* arise.



22



23

Fig. 22 – 23.
22 - *Dactylogyrus extensus*, morphological structure (ventral view, live worms). **23 -** *Dactylogyrus extensus*, haptor armament and copulatory organ.

The relationship between *D. extensus* and *D. vastator* seems to be antagonistic (Paperna, 1964b). The first can be found on carp gills when the second is absent, or it can be forced out by the second. Paperna proposes that a thermophilic strain of *D. extensus* has been formed in Israel during 30 years of carp culture there.

Control of *D. extensus* is the same as for *D. vastator*. Publications on biology and control

of ***D. extensus*** include Bauer, 1951, 1954, 1959; Izumova, 1953, 1958; Bauer and Nikolskaya, 1954; Prost, 1963; Paperna, 1964a; Kollmann, 1966; Schaeperclaus, 1979, 1992; Bauer et al., 1981.

27 (26). The tube of the copulatory organ is sickle shaped and 0.040 mm long; the accessory piece is short and of the "anchoratus" type. It is a parasite of Baikal cottoid fishes.
D. colonus Bogolepova, 1950 (Fig. 24)

These small or medium size worms can be up to 0.6 mm long and 0.2 mm wide. Length of marginal hooks is 0.025–0.031 mm. Length of anchors is 0.061–0.077 mm, main part 0.048–0.055 (after Bogolepova (1950) 0.036–0.048) mm, inner root 0.019–0.033 (0.028–0.032) mm, outer root 0.007–0.011 mm, point 0.023–0.027 mm. Size of bar is 0.010–0.013 (0.011–0.016) x 0.040–0.046 (0.028–0.043) mm. Length of copulatory organ is about 0.038 (0.026) mm, diameter of tube in its middle part 0.004–0.005 mm. Vaginal armament is absent.

Found on gill filaments of ***Limnocottus bergianus, L. godlewskii, L. pallidus, Cyphocottus megalops***, and ***Cottocomephorus grewingkii***; Lake Baikal.

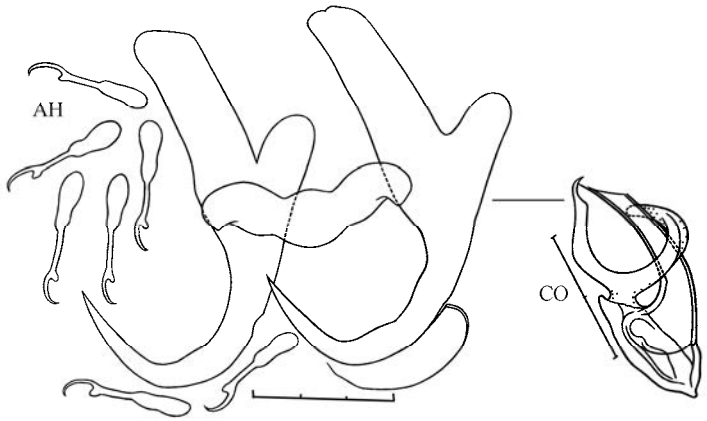


Fig. 24 - *Dactylogyrus colonus*.

28 (25). The total length of the anchors is less than 0.055 mm. The tube of the copulatory organ is nearly straight.

29 (30). The anchors are very thin; the inner root is less than twice short as the main part; the point smoothly turns into the main part without a sharp bend. The vaginal armament is a round structure with a short tube.
D. intermedius Wegener, 1910 (Fig. 25)
Syn.: ***D. mizellei*** C. Price, 1967

These worms range from small to large size; they can be up to 1.1 mm long and 0.22 mm wide. Length of marginal hooks is 0.015–0.037 mm. Length of anchors: dorso-apical 0.023–0.031 mm (ventro-apical are slightly longer), main part 0.020–0.025 mm, inner root 0.009–0.015 mm, outer root 0.003–0.005 mm, point 0.007–0.011 mm. Size of bar is 0.003–0.004 x 0.023–0.030 mm. Length of copulatory organ is 0.033–0.060 mm, diameter of tube in its middle part 0.003–0.005 mm. Vaginal armament is in the form of bubble-like structure of diameter 0.011–0.019 mm, with a short tube 0.012–0.015 mm.

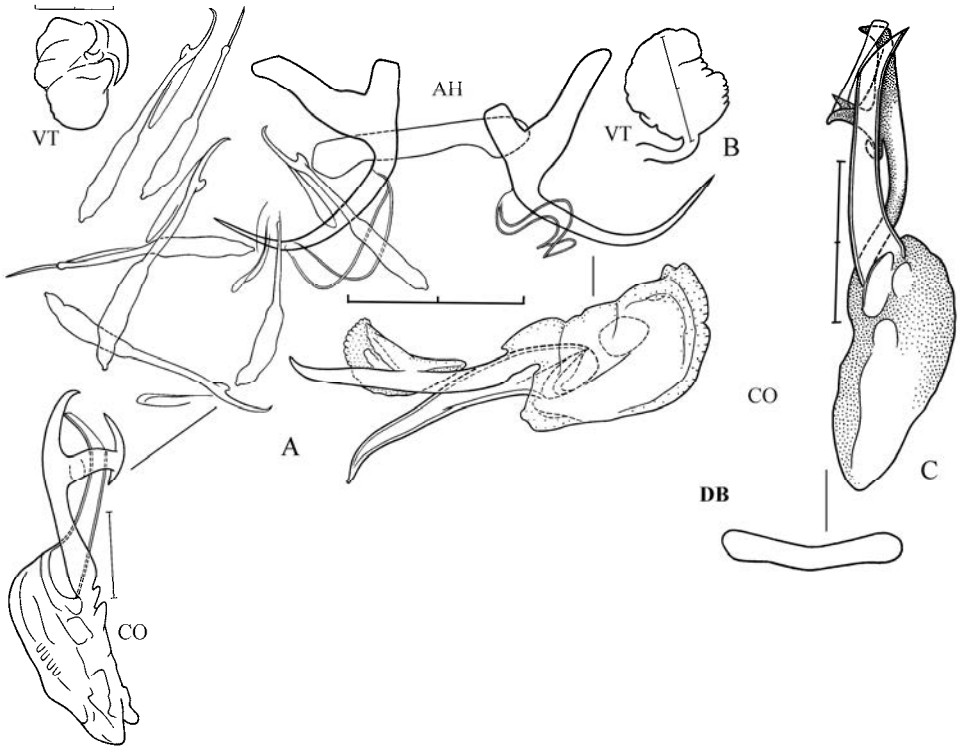


Fig. 25. - *Dactylogyrus intermedius*.

A – specimen from *Carassius carassius*, Volga River, Rybinsk Reservoir, near Borok village (Russia); B – vaginal tube after Ergens et Lom (1970); C – holotype of *"D. mizellei"*.

Found on gill filaments of *Carassius carassius, C. auratus gibelio*, and *Cyprinus carpio* (?). Its area of distribution is the same as that of its hosts.

D. mizellei was described from a cyprinodontoid South American fish kept in an aquarium in the United States. Its holotype has been compared with *D. intermedius* and no differences between these two species were found.

30 (31). The anchors are massive; the point smoothly turns into the main part without a sharp bend. Vaginal armament is absent.

D. intermedioides Gussev, Jalali et Molnar, 1993 (Fig. 26)

These small worms have a body length up to 0.5 mm and width to 0.1 mm. Total length of marginal hooks is 0.025–0.030 mm. The anchors are strong and have well-developed roots and a recurved point. Anchor length (dorso-apical) is 0.030–0.032 mm, main part 0.025–0.027 mm, inner root 0.013–0.015 mm, outer root 0.005–0.006 mm, point 0.008–0.009 mm. Size of dorsal bar is 0.004 x 0.031 mm. Length of copulatory organ is 0.040 mm, diameter of tube 0.002 mm, its initial part 0.017 x 0.009 mm.

Parasite of *Carassius auratus*; near Tehran, Iran.

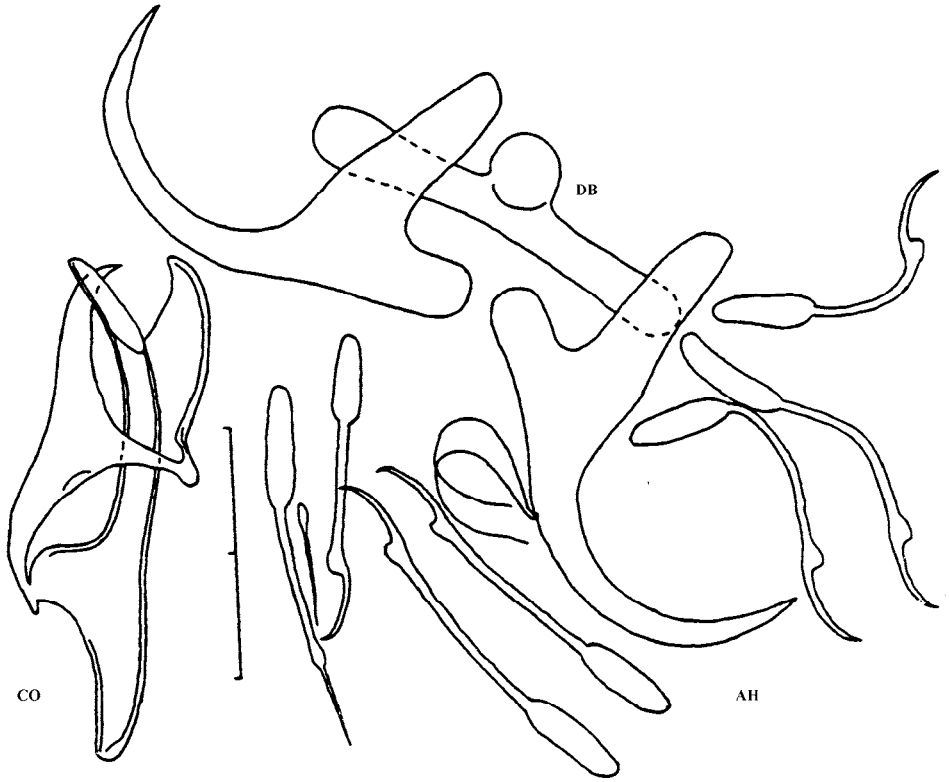


Fig. 26 - *Dactylogyrus intermedioides* (after Gussev et al., 1993c).

31 (30). The anchors are rather massive; the inner root usually is small (more than 2.3 times shorter than the main part); the main part turns into a point with a sharp bend. Vaginal armament is absent.

32 (37). The inner root of the anchors is 2.3–3 times shorter than the main part. The copulatory organ is of the "anchoratus" type; the initial part of the tube has a thickening or projection. These are parasites of *Cyprinus carpio* and *Gymnocephalus cernuus.*

33 (34). The tube of the copulatory organ has a lateral thickening on the expanded initial part. This is parasite of *Cyprinus carpio.*

D. minutus Kulwiec, 1927 (Fig. 27)

These are minute worms; body length is up to 0.48 mm and width to 0.10 mm. Length of marginal hooks is 0.017–0.027 mm. Length of anchors is 0.039–0.052 mm, main part 0.033–0.040 mm, inner root 0.012–0.018 mm, outer root 0.004–0.006 mm, point 0.012–0.015 mm. Size of bar is 0.003–0.006 x 0.024–0.032 mm. Length of copulatory organ is 0.029–0.045 mm.

Found on gill filaments of *Cyprinus carpio* and *C. c. rubrofuscus*; *D. minutus* is thermophilic species and so it is more often found in south zone of carp culture. Its area of distribution is the same as that of its hosts.

34 (33). The tube of the copulatory organ has a posterior process at its initial part. These are parasites of *Gymnocephalus cernuus.*

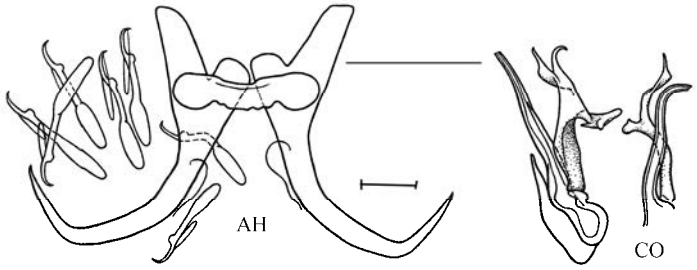
35 (36). The tube of the copulatory organ is long (about 0.040 mm without the posterior projection) and

nearly cylindrical after its initial part; the projection is long, sometimes as long as the tube.

D. amphibothrium Wagener, 1857 (Fig. 28)

These are small or medium size worms; body length can be up to 0.7 mm and width to 0.14 mm. Peculiar lateral oval structures of unknown nature (perhaps glands) are present behind the copulatory organ. Length of marginal hooks is 0.024–0.038 mm. Length of anchors is 0.033–0.043 mm, main part 0.028–0.035 mm, inner root 0.008–0.017 mm, outer root 0.005–0.009 mm, point 0.012–0.019 mm. Size of bar is 0.006–0.009 x 0.031–0.045 mm. Length of copulatory organ with projection is 0.055–0.070 mm.

27



28

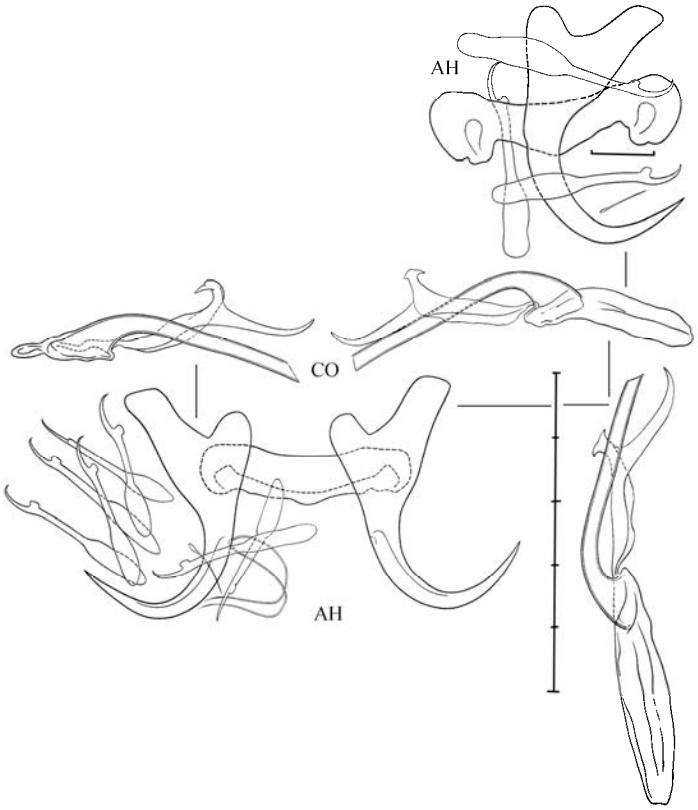


Fig. 27 – 28.

27 - *Dactylogyrus minutus* from Lake Khanka (Russia). **28 -** *Dactylogyrus amphibothrium* from Tisa River (Ukraine).

Found on gill filaments of *Gymnocephalus cernuus* and *G. schraetser*; basins of Caspian, Black, Baltic, and White (Sukhona River) Seas; water bodies of western Siberia, Kazakhstan (Lake Zaisan, Irgiz-Turgay Basin), and other water bodies inhabited by *Gymnocephalus cernuus*. It also is found in Great Britain.

36 (35). The tube of the copulatory organ is short (less than 0.030 mm without the projection) and broad; it becomes narrower near the obliquely cut of end of it; the length of the projection in most cases is less than that of the tube, sometimes it is difficult to see.
D. hemiamphibothrium Ergens, 1956 (Fig. 29)[18]

These are medium or large size worms; length can be up to 1.4 mm and width to 0.18 mm. Length of marginal hooks is 0.024–0.035 mm. Length of anchors is 0.032–0.037 mm, main part 0.025–0.029 mm, inner root 0.009–0.014 mm, outer root 0.003–0.006 mm, point 0.009–0.013 mm. Size of bar is 0.005–0.007 x 0.022–0.030 mm. Length of copulatory organ is 0.027–0.046 mm.

Found on gill filaments of *Gymnocephalus cernuus* and *G. schraetser*; water bodies of Czechia and Slovakia; Tisa and Volga Rivers (in the Rybinsk Reservoir); basins of the Ob' and Yenisey Rivers; it has been also found in Great Britain and Hungary.

37 (32). The inner root of the anchors is 3.5–4 times shorter than the main part. The copulatory tube is almost straight and the accessory piece resembles a plate with claw-shaped end; the initial part of the tube lacks processes. These are parasites of the genus *Triplophysa*.

38 (39). The length of the copulatory organ tube is less than 0.030 mm; its diameter in the middle part is 0.001 mm.
D. stankovici Ergens, 1970 (Fig. 30)

These minute worms have a body length up to 0.5 mm and width to 0.1 mm. Length of marginal hooks is 0.018–0.021 mm. Length of anchors is 0.038–0.042 mm, main part 0.035–0.037 mm, inner root 0.009–0.011 mm, outer root 0.003–0.004 mm, point 0.009–0.010 mm. Size of bar is 0.004–0.005 x 0.022–0.025 mm. Total length of copulatory organ is 0.028–0.033 mm.

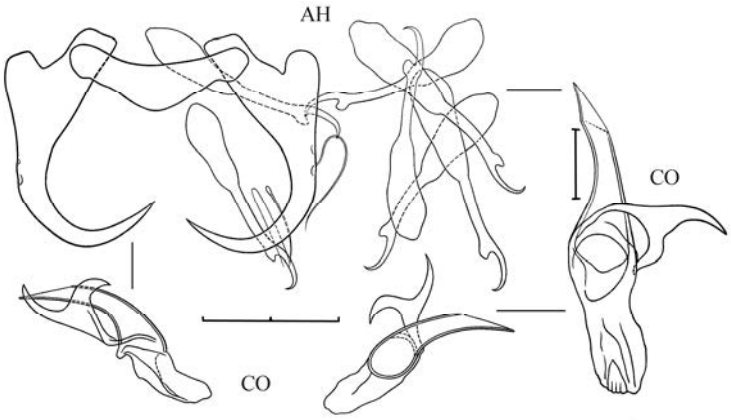
Found on gill filaments of *Triplophysa strauchi*; Tesiyn River and Lake Sangiin-Dalay (Mongolia).

According to the structure and measurements of its chitinoid elements, this species is very similar to *D. meridionalis*. The absence of the ventral bar of the haptor and the vaginal armament of *D. stankovici* may be result of mistake; they may be present but very thin and difficult to see. Whether or not these are two species will require further study.

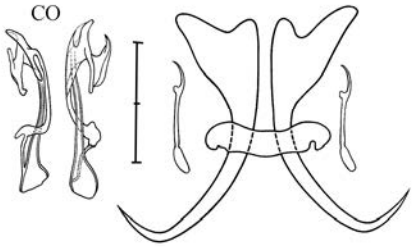
39 (38). The length of the copulatory tube is greater than 0.050 mm; the diameter of the middle part is greater than 0.002 mm.
D. assimovi Dzhalilov, 1970 (Fig. 31)

These are small or medium size worms; body length can be up to 0.7 mm and width to 0.17 mm. Length of marginal hooks is 0.024–0.027 mm. Length of anchors is 0.043–0.051 mm, main part 0.042–0.045 mm, inner root 0.010–0.012 (first description 0.018–0.021, which seems to be impossible) mm, outer root 0.004–0.007 mm, point 0.015–0.016 mm. Size of bar is 0.007–0.009 x 0.029–0.031 mm. Length of copulatory organ tube is 0.053–0.063 mm.

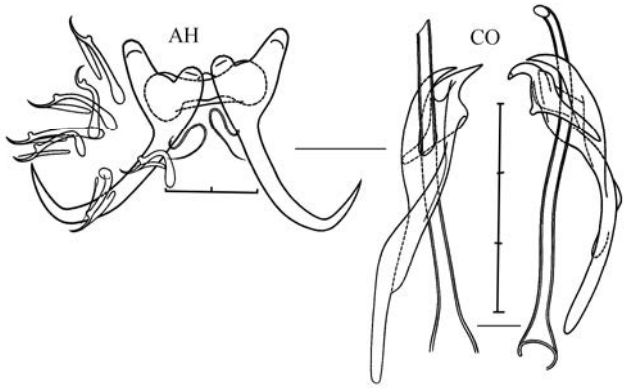
[18] A very thin and minute structure was found in crushed but unfixed specimens of *D. amphibothrium* and *D. hemiamphibothrium* from ruffs caught in the Tisa River in 1962. It was stick shaped (length about 0.01 mm) with a very poorly visible projection. It was not seen on glycerin gelatinous slides. Perhaps it was a tendon or a muscle, but it might be a second bar. Further study of this structure is necessary.



29



30



31

Fig. 29 – 31.
29 - *Dactylogyrus hemiamphibothrium* (on the right - copulatory organ from specimen of Iriklinskoye Reservoir, Volga River, Russia). **30 -** *Dactylogyrus stankovici* (after Ergens, 1970). **31 -** *Dactylogyrus assimovi*.

Found on gill filaments of *Triplophysa stoliczkai* and *T. lacusnigri*; Lake Karakul' (Pyandzh River Basin, Tajikistan).

40 (4). The anchors are of the “anchoratus” and “pseudanchoratus” type, or near to them; they lack an outer root, or have a very poor one, but they have a long and narrow inner root that is longer than 10 times the outer one (if it exists). The copulatory organ of the majority of species is of the “anchoratus” type (sometimes with modifications).

41 (60). The anchors are of the “anchoratus” type.

42 (43). The haptor bar is bent into a **U** shape. The tube of the copulatory organ is bottle shaped; its initial part has a pectinated outgrowth; the accessory piece and its projection are bifurcated at their ends.

D. formosus Kulwiec, 1927 (Fig. 32)

These are small worms; total body length can be up to 0.54 mm, width to 0.11 mm. Length of marginal hooks is 0.012–0.030 mm. Length of anchors is 0.060–0.074 (0.045–0.050 in Chen et al., 1973) mm, main part 0.040–0.045 mm, inner root 0.030–0.035 mm, point 0.018–0.022 (0.019-0.028) mm. Size of bar is 0.003–0.005 x 0.014–0.025 mm. Total length of copulatory organ is 0.025–0.032 mm.

Found on gill filaments of *Carassius carassius* and *C. auratus gibelio*; indications of *D. formosus* on other fishes are doubtful or accidental. Its area of distribution seems to be the same as that of its hosts.

43 (42). The bar is straight or bent slightly backwards. The tube of the copulatory organ lacks a pectinated outgrowth; sometimes a straight or bent projection is present; the tube is widened only at the initial part or at its end and the rest of it is tapered or cylinder shaped; the projection and the end of the accessory piece lack bifurcation.

44 (45). The anchors are very long (up to 0.13 mm); their inner root is twice as long as the point; the ratio of the length and width of the bar is 1:2.5–1:4.

D. anchoratus (Dujardin, 1845) (Fig. 33)

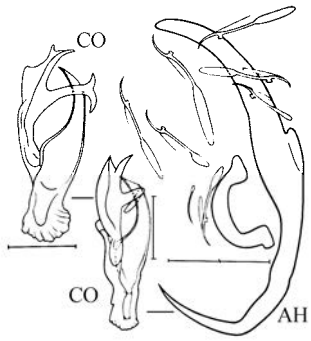
These are small or medium size worms; length can be up to 0.74 mm, width to 0.10 mm. Length of marginal hooks is 0.014–0.035 mm. Length of anchors is 0.092–0.130 mm, main part 0.057–0.076 mm, inner root 0.043–0.070 mm, point 0.024–0.032 mm. Size of bar is 0.005–0.008 x 0.018–0.029 mm. Length of copulatory organ is 0.020–0.036 mm.

Found on gill filaments of *Carassius carassius*, *C. auratus gibelio*, *Cyprinus carpio*, *C. c. rubrofuscus*, *Gobio gobio* (?), and *Leucaspius delineatus* (?); its area of distribution is the same that of its hosts in Europe and Asia; it has been transferred to North America.

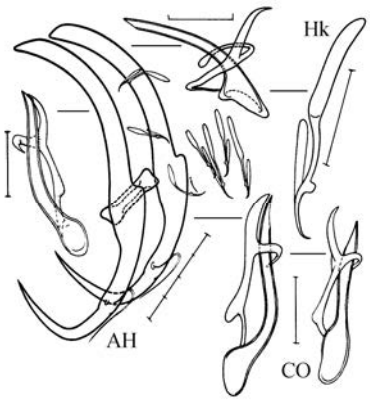
45 (44). The length of the anchors is less than 0.10 mm (mostly less than 0.060); its inner root is the same length or slightly longer than the point; the ration of the length and width of the bar is 1:6–1:11.

46 (55). The widened initial part of the copulatory organ tube lacks a projection or thickenings; the tube is sickle shaped or straight.

47 (50). The tube of the copulatory organ is strongly sickle shaped and curved, after which the widened initial part becomes nearly cylindrical.

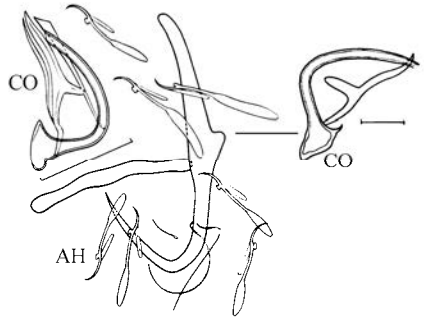


32



33

34



35

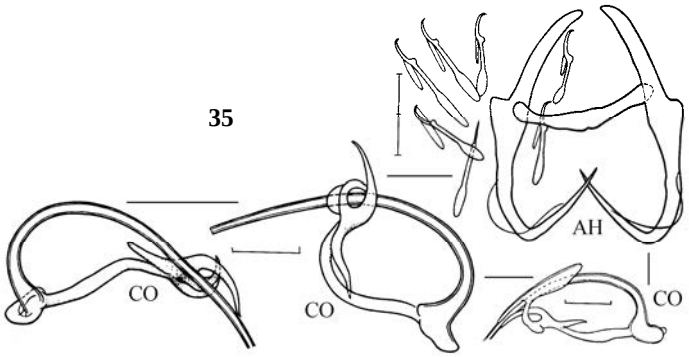


Fig. 32 – 35.
32 - *Dactylogyrus formosus* (after Gussev, 1962). **33 -** *Dactylogyrus anchoratus* (after Gussev, 1962). **34 -** *Dactylogyrus wegeneri*. **35 -** *Dactylogyrus baueri* (after Gussev, 1955a, 1962).

48 (49). The accessory piece of the copulatory organ resembles a straight plate that is slightly undulated with a finger-shaped projection and a membrane-like edging; its end is pointed.
D. wegeneri Kulwiec, 1927 (Fig. 34).

These are small worms; length is less than 0.5 mm and width 0.13 mm. Length of marginal hooks is 0.014–0.033 mm. Length of anchors is 0.039–0.062 mm, main part 0.024–0.032 mm, inner root 0.020–0.028 mm, point 0.017–0.023 mm. Length Size of bar is 0.002–0.003 x 0.025–0.033 mm. Total length of copulatory organ is 0.024–0.037 mm.

Found on gill filaments of *Carassius carassius* and *C. auratus gibelio*; water bodies of Europe, western Siberia, central Asia (erroneously noted for France, see *D. dulkeiti*).

49 (48). The accessory piece of the copulatory organ has three pointed projections; two of them are beak shaped and bent one toward the other.
D. baueri Gussev, 1955 (Fig. 35)

These are small worms; length is 0.35 mm, width 0.07 mm. Length of marginal hooks is 0.013–0.025 mm. Length of anchors is 0.041–0.054 mm, main part 0.020–0.026 (after Lambert (1977a) up to 0.029) mm, inner root 0.020–0.030 mm, point 0.021–0.028 (after Ergens and Lom (1970) 0.013–0.022) mm. Size of bar is 0.002–0.003 x 0.026–0.036 (after Chen et al. (1973) 0.036–0.045) mm. Length of copulatory organ is 0.031–0.047 mm.

Found on gill filaments of *Carassius auratus gibelio*, *C. carassius* (?), and *Cyprinus carpio*; water bodies of the Amur region; found also in the basins of the Ob' and Yenisey Rivers (western Siberia), Selenga River (North Mongolia), and southern France.

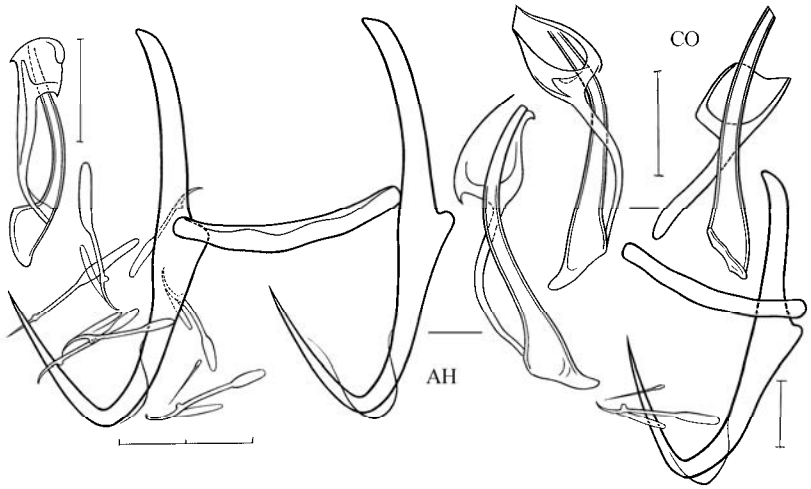
50 (47). The tube of the copulatory organ is almost straight or slightly bent and tapering to its end.

51 (54). The accessory piece of the copulatory organ is almost straight and has a membrane between its end and the lateral projection. These are parasites of the genus *Carassius.*

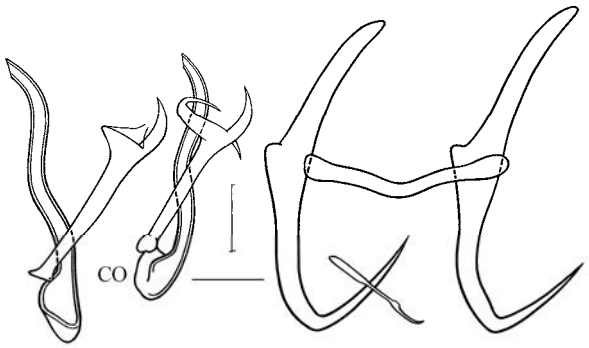
52 (53). The tube of the copulatory organ is almost straight and has thin walls; the end of the accessory piece is spatulate.
D. dulkeiti Bychowsky, 1936 (Fig. 36)
Syn.: *D. inexpectatus* in Vicente et al., 1975; *D. wegeneri* in Lambert, 1975

These minute worms have a body length up to 0.38 mm and width to 0.08 mm. Length of marginal hooks is 0.014–0.026 mm. Length of anchors is 0.045–0.057 mm, main part 0.029–0.033 mm, inner root 0.021–0.030 mm, point 0.022–0.024 mm. Size of bar is 0.002–0.003 x 0.024–0.026 mm. Length of copulatory organ is 0.021–0.029 mm.

Found on gill filaments of *Carassius carassius* and *C. auratus gibelio*; basins of Caspian, Black, Baltic, and White Seas; water bodies of Kazakhstan and Siberia (Ob', Yenisey, and Lena Rivers), Selenga River (Mongolia), Amur, Liao He, and Yangtze Rivers; found in France.



36



37

Fig. 36-37.
36 - *Dactylogyrus dulkeiti*. **37 -** *Dactylogyrus inexpectatus* (after Gussev, 1962).

53 (54). The tube of the copulatory organ has thick walls and undulates; the end of the accessory piece is spanner-like.

D. inexpectatus Iziumova in Gussev, 1955 (Fig. 37)

These are minute worms; body length can be up to 0.34 mm and width to 0.08 mm. Length of marginal hooks is 0.012–0.029 mm. Length of anchors is 0.037–0.053 mm, main part 0.023–0.030 mm, inner root 0.018–0.027 mm, point 0.015–0.021 mm. Size of bar is 0.002–0.003 x 0.024–0.036 mm. Length of copulatory organ is 0.029–0.048 mm.

Found on gill filaments of *Carassius carassius*, *C. auratus gibelio*, and *Cyprinus carpio* (?); it seems to be distributed throughout the area of its hosts, but to date has been found only in some river basins of the Black and Baltic Seas and in Siberia and the Amur region; it also has been found in the Liao He and Yangtze Rivers.

54 (51). The accessory piece of the copulatory organ is of the "anchoratus" type and is slightly **S**-shape; its lateral projection turns around the tube. This is a parasite of the genus *Schizopygopsis.*

D. pamirensis Dzalilov et Ashurova, 1971 (Fig. 38)

These are minute worms; body length can be up to 0.21 mm, width to 0.05 mm. Length of marginal hooks is 0.016–0.020 mm. Length of anchors is 0.048–0.056 mm, main part 0.033–0.038 mm, inner root 0.020–0.024 mm, point 0.018–0.019 mm. Size of bar is 0.003–0.005 x 0.025–0.028 mm. Length of copulatory organ is 0.033–0.037 mm.

Found on gill filaments of *Schizopygopsis stoliczkai*; Pyandz River Basin (Tajikistan).

55 (46). The widened initial part of the curved tube of the copulatory organ has thickened walls and a massive finger-shaped supporting projection directed forward (to its anterior end).

56 (59). The tube of the copulatory organ tapers to its obliquely cut end. Vaginal armament is present. These are parasites of the genus *Schizopygopsis.*

57 (58). The accessory piece of the copulatory organ is bifurcated at its end.

D. irinae Dzalilov, 1970 (Fig. 39)

These minute or medium size worms have a body length up to 0.6 mm and width to 0.17 mm. Length of marginal hooks is 0.024–0.031 mm. Length of anchors is 0.052–0.065 (in original description 0.060–0.093) mm, main part 0.033–0.038 (0.030–0.055) mm, inner root 0.027–0.031 (0.028–0.042) mm, outer root about 0.002 mm, point 0.021–0.023 (up to 0.033 ?) mm. Size of bar is 0.005–0.007 x 0.040–0.046 mm. Length of copulatory organ is 0.050–0.057 (0.063–0.067) mm. Vaginal armament is mushroom shaped and up to 0.010 mm long.

Found on gill filaments of *Schizopygopsis stoliczkai*; Pyandz River Basin (Tajikistan).

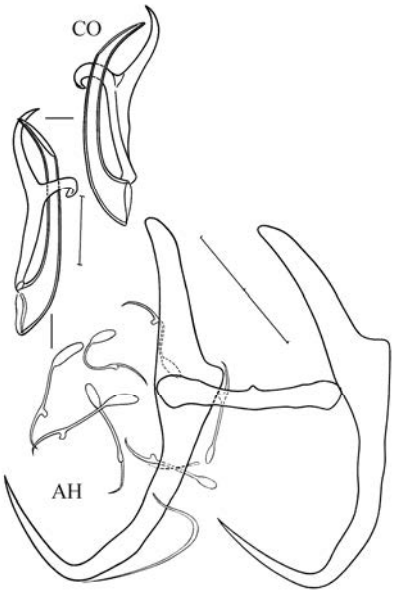
58 (57). The accessory piece of the copulatory organ has three projections at its end; one is shorter than the others.

D. schizopygopsis Dzalilov, 1970 (Fig. 40)

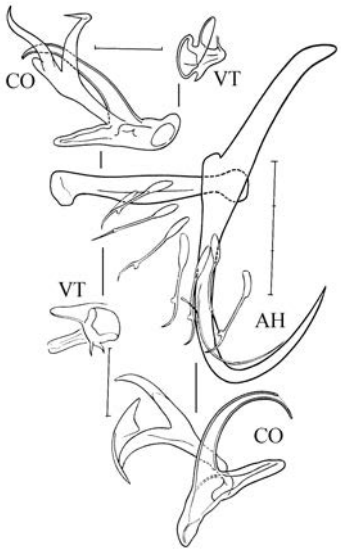
These are minute worms, body length can be up to 0.45 mm, width to 0.10 mm. Length of marginal hooks is 0.020–0.030 mm. Length of anchors is 0.080–0.090 (original description up to 0.099) mm, main part 0.046–0.055 (up to 0.060) mm, inner root 0.033–0.036 (0.037-0.045) mm, outer root about 0.002 (0.003–0.004?) mm, point 0.030–0.036 mm. Size of bar is 0.006–0.007 x 0.045–0.048 (0.048–0.060) mm. Total length of copulatory organ is 0.030–0.037 (up to 0.045) mm. The fungiform vaginal armament is 0.008–0.012 mm long and has a "funnel" at the end.

Found on gill filaments of *Schizopygopsis stoliczkai*; Pyandz River Basin (Tajikistan).

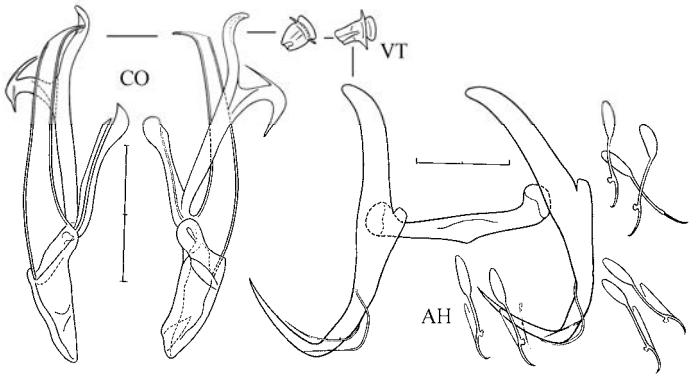
59 (56). The copulatory tube widens at its end to form a bell. Vaginal armament is absent.



38



40



39

Fig. 38 – 40.
38 - *Dactylogyrus pamirensis*. **39 -** *Dactylogyrus irinae*. **40 -** *Dactylogyrus schizopygopsis*.

D. simplex Bychowsky, 1936 (Fig. 41)

These minute worms have a body length up to 0.35 mm, width to 0.08 mm. Length of marginal hooks is 0.019–0.025 (original description 0.013–0.024) mm. Length of anchors is 0.055–0.065 (0.053–0.057) mm, main part 0.036–0.043 mm, inner root 0.018–0.022 mm, outer root 0.001 (0.002–0.003) mm, point 0.025–0.027 mm. Size of bar is 0.003–0.005 x 0.035–0.041 mm. Length of copulatory organ is 0.040–0.047 mm.

Found on gill filaments of *Gymnodiptychus dybowskii* and *Diptychus maculatus*; water bodies of Central Asia and Kazakhstan.

60 (41). The anchors are of the “pseudanchoratus” type and have a swelling on the main part; long inner and short outer roots are present. The copulatory tube has ball-shaped initial part; the accessory piece is in the form of one or several plates placed in parallel with the copulatory tube. These are parasites of *Garra rufa.*

61 (62). The vaginal armament is in the form of short tube with disc-like plates at each end.
D. rectotrabus Gussev, Jalali et Molnar, 1993 (Fig. 42)

These are small worms; body length can be up to 0.4 mm and width to 0.085 mm. Total length of marginal hooks is 0.015–0.022 mm. Length of anchors is 0.036 mm, main part 0.024 mm, inner root 0.015 mm, outer root < 0.001 mm, point 0.010 mm. Size of dorsal bar is 0.002 x 0.018 mm. Length of copulatory organ tube is about 0.060 mm, diameter at the initial part 0.008 mm. Length of vaginal armament is 0.007 mm, diameter of tube 0.002 mm.

Parasite of *Garra rufa*; Dez River, water system of the Tigris River, Iran.

62 (61). Vaginal armament is absent.
D. acinacus Gussev, Jalali et Molnar, 1993 (Fig. 43)

These small worms have a body length up to 0.44 mm and width to 0.09 mm. Total length of marginal hooks is 0.018–0.022 mm. Length of anchors is 0.032–0.036 mm, main part 0.023–0.026 mm, inner root 0.015–0.016 mm, outer root 0.003–0.0035 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.003 x 0.019–0.021 mm. Total length of copulatory organ is 0.023–0.028 mm, length of the tube along the curve 0.035–0.040 mm, diameter of its initial part 0.006–0.008 mm, elsewhere 0.001–0.002 mm. Vaginal armament is up to 0.010 mm long.

Parasite of *Garra rufa*; Dez River, water system of the Tigris River, Iran.

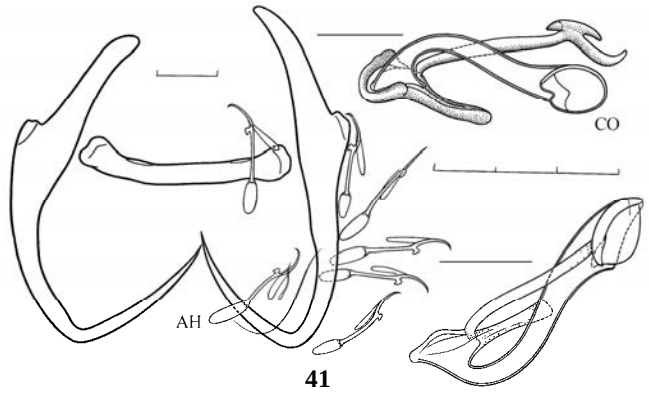
63 (3). The haptor has a dorsal bar and a ventral bar. The copulatory organ can be of different types. The haptor of the “sphyrna” type lacks a ventral bar.

64 (77). The ventral bar is in the form of a “flying bird” or is “**Λ”–** shaped.

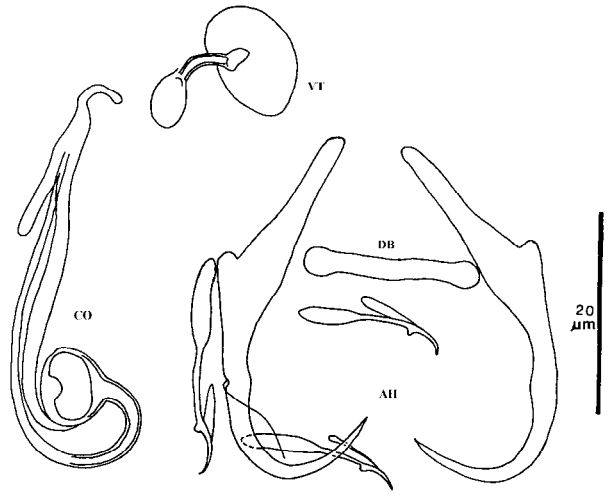
65 (67). The copulatory organ is near to or derived from the “anchoratus” type. The anchors are of different types.

66 (70). The marginal hooks are of the larval (embryonic) type; handles are absent or very short.

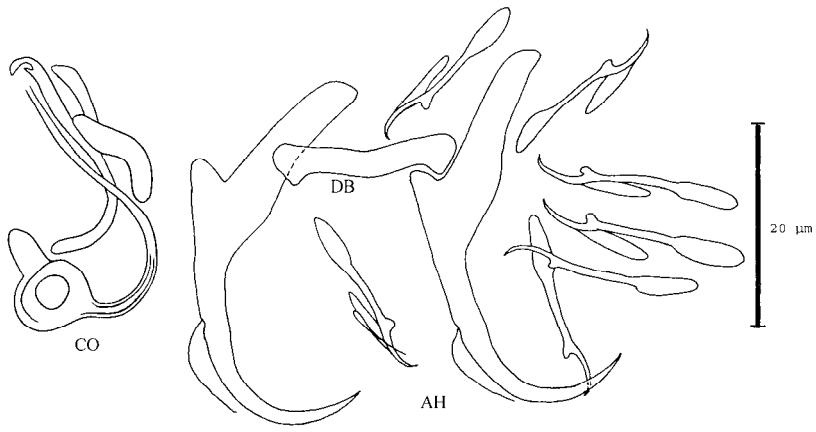
67 (68). The anchor points are slightly counter curved after their sharp bend. The anchors have a long inner root; anchor length is 0.031–0.035 mm.
D. mobedii Jalali, Shamsi et Molnar, 2000 (Fig. 44).



41



42



43

Fig. 41-43.
41 - *Dactylogyrus simplex*. **42 -** *Dactylogyrus rectotrabus* (after Gussev et al., 1993b). **43 –** *Dactylogyrus acinacus* (after Gussev et al., 1993b).

Body length is 0.222 (0.199–0.246) mm, width 0.040 (0.034–0.080) mm. Total length of marginal hooks is 0.013 (0.010–0.016) mm. Dorso-apical length of anchor is 0.033 (0.031–0.034) mm, ventro-apical 0.024 (0.023–0.025) mm, outer root 0.003 (0.002–0.005) mm, inner root 0.016 (0.012–0.018) mm, point 0.007 mm. Size of dorsal bar is 0.003 (0.002–0.004) x 0.013 (0.012–0.013) mm, ventral bar 0.007 (0.005–0.010) x 0.008 (0.008–0.009) mm. Total length of copulatory organ is 0.021 (0.019–0.022) mm. The vaginal armaments is a coiled tube with a straight end. Length of tube is 0.006 (0.005–0.007) mm, diameter of the tube 0.001 mm.

Found on gills of *Aspidoparia mora*; from Bahu-Kalat River, close to the city of Pishin, Mokran Basin, Iran.

68 (69). The anchors are slender and have distinct but relatively small inner and outer roots.
D. yousefpouri Jalali, Shamsi et Molnar, 2000 (Fig. 45)

Body length is 0.222 (0.196–0.250) mm, width 0.044 (0.030–0.080) mm. Total length of marginal hooks is 0.016 (0.015–0.018) mm. Dorso-apical length of anchor is 0.027 (0.026–0.028) mm, ventro-apical 0.024 (0.023–0.025) mm, outer root 0.002 (0.002–0.004) mm, inner root 0.007 (0.006–0.009) mm, point 0.009 (0.008–0.010) mm. Size of dorsal bar is 0.002 (0.002–0.003) x 0.015 (0.013–0.019) mm, ventral bar 0.001 x 0.006 mm. Total length of copulatory organ is 0.019 (0.013–0.023) mm. Length of the supporting structure of the vagina is 0.011 (0.010–0.012) mm, diameter at the straight part 0.0018 (0.0017–0.002) mm. Length of vaginal tube is 0.007 (0.006–0.007) mm, width of the wider tubular opening 0.002 (0.002–0.003) mm.

Parasite of *Aspidoparia mora*; Bahu-Kalat River, close to the city Pishin, Mokran River Basin, Iran.

69 (68). The anchors are massive and of the "wunderi" type and have a long point.
D. faridpaki Jalali, Shamsi et Molnar, 2000 (Fig. 46)

Body length is 0.459 (0.430–0.479) mm and width is 0.0915 (0.076–0.111) mm. Total length of marginal hooks is 0.015 (0.007–0.018) mm. Dorso-apical length of anchor is 0.029 (0.028–0.030) mm, ventro-apical 0.021 (0.017–0.023) mm, outer root 0.002 mm, inner root 0.010 mm, point 0.011 (0.011–0.012), mm. Size of dorsal bar is 0.004 (0.003–0.005) x 0.014 (0.012–0.016) mm. Ventral bar is 0.001 x 0.011 (0.011–0.012) mm. Total length of copulatory organ is 0.037 (0.032–0.039) mm. Length of vaginal armament is 0.025 (0.024–0.026) and 0.004 (0.004–0.005) mm in diameter.

Found on gills of *Crossocheilus latius;* from Bahu-Kalat River, close to the city of Pishin, Mokran Basin, Iran.

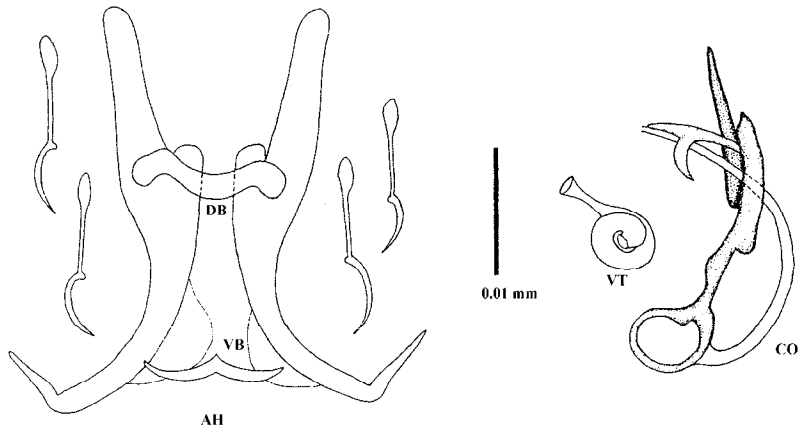
70 (66). The marginal hooks have "normal" handles.

71 (72). The vaginal armament is bean shaped and has a cup-shaped structure on one side and a massive enlargement on the other.
D. barbioides Gussev et al., 1993 (Fig. 47)

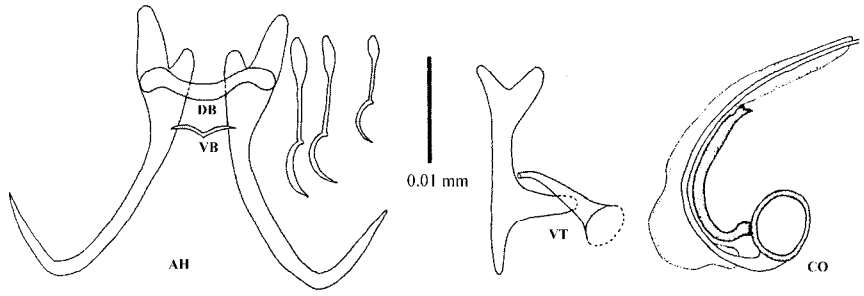
Body length can be up to 0.565 mm long and 0.160 mm wide. Total length of marginal hooks is 0.030 mm (1st pair), 0.040 mm (2nd pair) mm. Length of anchors is 0.054–0.056 mm, main part 0.049–0.051 mm, inner root 0.021–0.032 mm, outer root 0.008 mm, point 0.017–0.018 mm. Size of dorsal bar is 0.003–0.008 x 0.035–0.041 mm, ventral bar 0.001–0.002 x 0.025–0.028 mm. Length of copulatory organ is absent in the original description. Vaginal armament is 0.022 x 0.011 mm.

Found on gills of *Luciobarbus grypus* from the Tigris River, near Baiji, Iran.

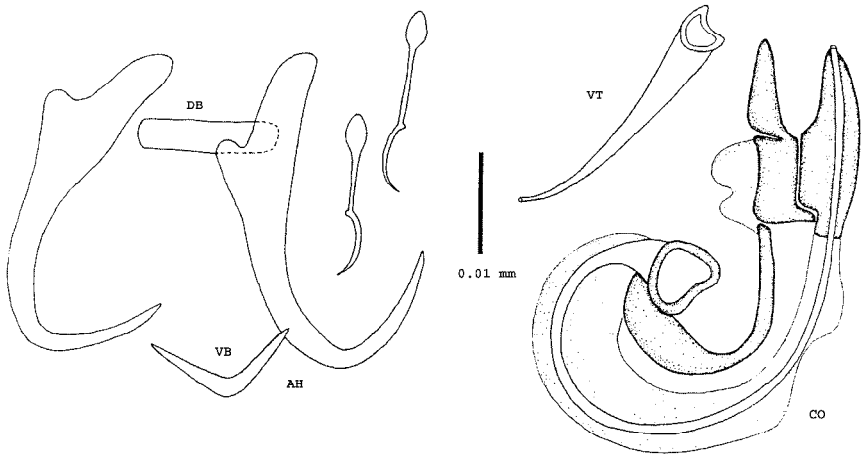
72 (71). Vaginal armament is absent.



44



45



46

Fig. 44 – 46.
44 - *Dactylogyrus mobedii* (after Jalali et al., 2000). **45 -** *Dactylogyrus yousefpouri* (after Jalali et al., 2000). **46 -** *Dactylogyrus faridpaki* (after Jalali et al., 2000).

73 (76). The dorsal bar is "**V**"– shaped with a rearward membrane or wide projection.

74 (75). The length of the anchors is 0.035mm. The length of the copulatory organ is greater than 0.020 mm.
D. cyprinioni Gussev, Jalali et Molnar, 1993 (Fig. 48)

Body length can be up to 0.5mm and width to 0.1mm. Total length of marginal hooks is 0.018–0.025mm. The anchors are of the "wunderi" type and have well-developed roots and a short recurved point. Length of anchors is 0.035mm, main part 0.028 mm, inner root 0.01mm, outer root 0.003 mm, point 0.007 mm. Size of dorsal bar is 0.0033 x 0.022 mm, ventral bar 0.002 x 0.019mm. Length of copulatory organ is 0.027 mm, diameter at the initial part 0.006 mm, in the middle 0.001 mm.

Found on gills of *Cyprinion macrostomum*; from the Kharoon River, water system of the Tigris River, Iran.

75 (74). Length of the anchors is less than 0.035 mm. Length of the copulatory organ is less than 0.020 mm.
D. microcirrus Gussev, Jalali et Molnar, 1993 (Fig. 49)

These are small worms; body length is 0.4 mm and width is 0.1 mm. Total length of marginal hooks is 0.017–0.029 mm. The anchors have a small outer root that is about six times shorter than the inner root. Length of anchors is 0.031–0.032 mm, main part 0.024–0.025 mm, inner root 0.012 mm, outer root 0.002 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.003–0.004 (0.009 with projection) x 0.017–0.019 mm, ventral bar 0.001–0.002 x 0.019–0.020 mm. Length of copulatory organ is 0.014–0.016 mm, diameter of tube 0.001 mm, although 0.007 mm at the initial part.

Found on gills of *Capoeta trutta*; Dez River, water system of the Tigris River, Iran.

76 (73). The dorsal bar lacks a membrane or projections; the ventral bar is "**Λ**" shaped. The length of the copulatory organ is 0.040 mm.
D. macrostomi Gussev, Ali, Abdul-Ameer, Amin et Molnar, 1993 (Fig. 50)

Body length can be up to 0.688 mm and width to 0.071 mm. Length of marginal hooks is 0.025–0.033 mm. Length of anchors is 0.042–0.046 mm, main part 0.035–0.037 mm, inner root 0.014–0.017 mm, outer root 0.003–0.004 mm, point 0.011–0.014 mm. Size of dorsal bar is 0.003–0.004 x 0.028–0.030 mm, ventral bar 0.003–0.004 x 0.011–0.012 mm. Total length of copulatory organ is 0.040 mm, diameter of tube 0.002 mm, its initial part 0.010 x 0.007 mm.

Found on gills of *Cyprinion macrostomum*; Tigris River, near Baiji, Iran.

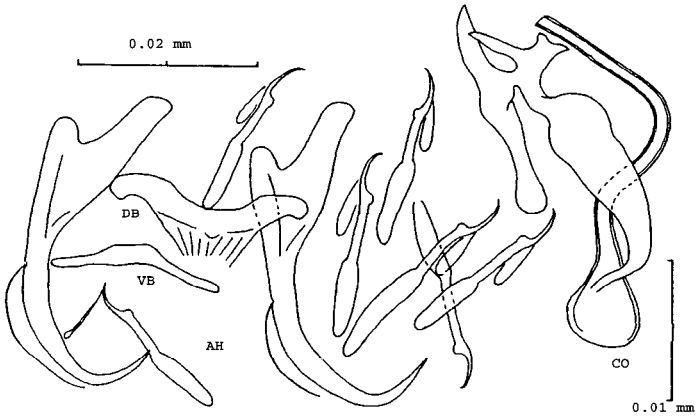
77 (64). The ventral bar is **V** shaped; the second pair of marginal hooks differ from the others (the blade and heel are 1.5 times longer than the others).
D. bicornis Malewitzkaja, 1941 (Fig. 51)

These are minute worms; body length can be up to 0.5 mm, width to 0.15 mm. Length of marginal hooks of the first and III–YII pairs is 0.018–0.034 mm, blade and heel (of hooklet) about 0.007 mm; II pair 0.031–0.032 mm, blade 0.010 mm. Length of anchors is 0.030–0.037 mm, main part 0.023–0.028 mm, inner root 0.010–0.012 mm, outer root 0.003–0.005 mm, point 0.006–0.008 mm. Size of dorsal bar is 0.003–0.004 x 0.023–0.027 mm, ventral bar 0.019–0.025 x 0.019–0.023 mm. Total length of copulatory organ is 0.050–0.060 mm, tube (along the curve) 0.087–0.110 mm, accessory piece 0.040–0.047 mm. Vaginal tube is very thin and difficult to see; its length is about 0.065 mm.

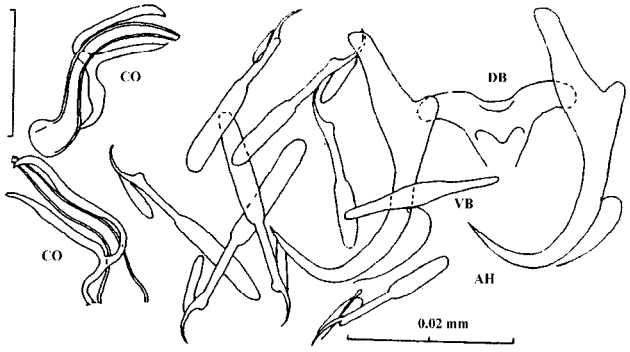
Found on gill filaments of ***Rhodeus amarus*** and ***Acanthorhodeus asmussi***; it seems to be distributed throughout the area of its hosts but to date has been found only in rivers of the Black Sea Basin and in the Amur River and in the Elbe and Oder Rivers (Czechia).

78 (77). The ventral bar is of a different shape; the blade and heel of the marginal hooks of the II pair do not differ from the others.

47



48



49

Fig. 47 – 49.
47 – *Dactylogyrus barbioides* (after Gussev et al., 1993a). One unit of scale–bar = 0.01 mm. **48 -** *Dactylogyrus cyprinioni* (after Gussev et al., 1993c). **49 -** *Dactylogyrus microcirrus* (after Gussev et al., 1993c).

79 (100). The copulatory organ is ring shaped (of the “chondrostomi” type). The vaginal armament is present in most cases as a long tube.

80 (85). The ventral bar of the haptor resembles a thin transverse stick without projections; its middle part is slightly broader than its ends.

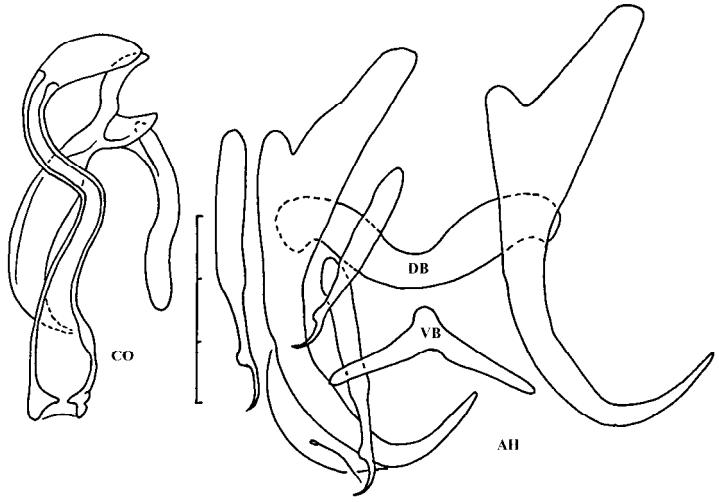
81 (82). The anchors have an open point that forms one long blade with the shaft of the anchor's main part; it is sharply bent only at its end (the “falcatus” type of anchor).
D. tuba Linstow, 1878 (Fig. 52, 53)

These worms are minute or medium size; body length can be up to 0.6 mm, width to 0.10 mm. Length of marginal hooks is 0.017–0.027 mm. Length of anchors: dorso-apical 0.026–0.029 (of specimens of ide fingerlings) –0.045 mm, ventro-apical 0.033 (of ide fingerlings) –0.050 mm, main part 0.030 (of ide fingerlings) –0.042 mm, inner root 0.009–0.017 mm, outer root 0.004–0.007 mm, blade 0.023 (of ide fingerlings) –0.035 mm. Size of dorsal bar is 0.004–0.008 x 0.027–0.037 mm, ventral bar 0.004 x 0.026–0.029 mm (Gussev, 1962). Total length of copulatory organ is 0.030–0.037 x 0.025–0.027 mm (from ide fingerlings and dace from the Tisa River) and 0.040–0.088 x 0.030–0.050 mm (from other fishes), tube 0.096–0.160 mm. Length of vaginal tube is 0.099–0.0127 (from fingerlings of ide and dace from the Tisa River) –0.170–0.210 mm.

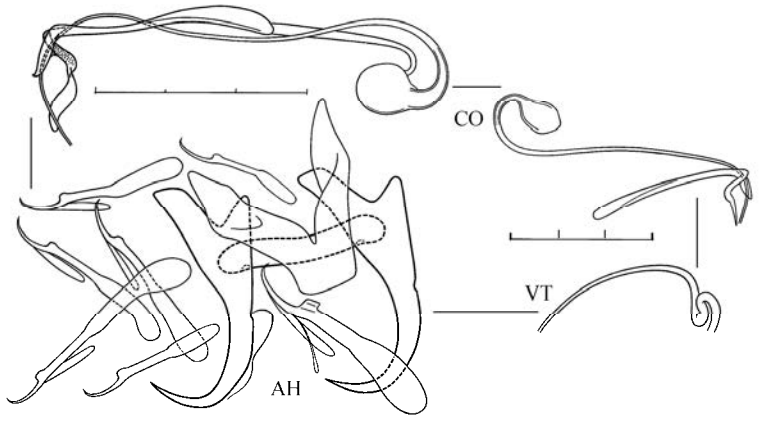
Found on gill filaments of *Leuciscus leuciscus*, *L. l. baicalensis*, *L. lehmanni*, *L. idus*, *L. idus oxianus*, *Aspius aspius*, *Aspiolucius esocinus*, *Alburnoides bipunctatus echwaldi* (?), *Vimba vimba* (?), *Rutilus rutilus lacustris* (?), and *Cyprinus carpio* (?). It may be widespread in Eurasian water bodies; parasite of fishes of the genus *Leuciscus* mainly.

Great variability has been noted in the shape and measurements of sclerotized structures. Some of these variations are as follows: 1) the typical form, mostly from *L. leuciscus*, has thin anchors, a ventro-apical length less than 0.040 mm, the declinate tip of the point of the anchors is about 0.002 mm, the copulatory organ is nearly round (diameter up to 0.035 mm), and the vaginal tube is rather short (Fig. 52: Ab, B); 2) from *L. idus*, this form has massive anchors, a ventro–apical length of 0.048–0.050 mm with a nearly straight point and a declinate tip up to 0.004 mm long, usually an elliptical copulatory organ, and a vaginal tube that is longer than that found in type 1 (Fig. 52: Ab, B-D); 3) from *Aspius aspius*, this form’s anchor blade is shorter and more smoothly curved and has a declinate tip about 0.005 mm long; the copulatory organ is elliptical as in type 2, and the vaginal tube can be up to 0.21 mm long (Fig. 52: Ad, E); 4) from *Aspiolucius*, this form differs from type 3 due to its very massive bar (although it is not always massive) and rather long declinate anchor tip (up to 0.010 mm) (Fig. 52: Ae; Fig. 53: G)

82 (81). The anchors have a declinate point that passes to the main part of the anchor with a more or less marked bend.



50



51

Fig. 50 – 51.
50 - *Dactylogyrus macrostomi* (after Gussev et al., 1993a). One unit of scale–bar = 0.01 mm. **51 -** *Dactylogyrus bicornis.*

83 (84). The anchors are 2–2.5 times longer than the marginal hooks; the ratio of the length and width of the bar, which has chinks on each side, is 1:2–2.5.

D. chondrostomi Malevitskaya, 1941 (Fig. 54)

These are worms of minute or medium size; body length can be up to 0.75 mm and width to 0.15 mm. Length of marginal hooks is 0.015–0.025 mm. Length of anchors is 0.050–0.060 mm, main part 0.040–0.047 mm, inner root 0.017–0.022 mm, outer root up to 0.002 mm, point 0.014–0.016 mm. Size of dorsal bar is 0.010–0.015 x 0.018–0.021 mm, ventral bar 0.001 x 0.016–0.018 mm. Length of copulatory organ is 0.045–0.056 mm, vaginal tube 0.11–0.12 mm long.

Found on gill filaments of *Chondrostoma nasus, C. oxirhynchum,* and *C. knerii*; water bodies of the Black Sea Basin; Ural River (Caspian Sea Basin); Lake Skadar (former Yugoslavia); France.

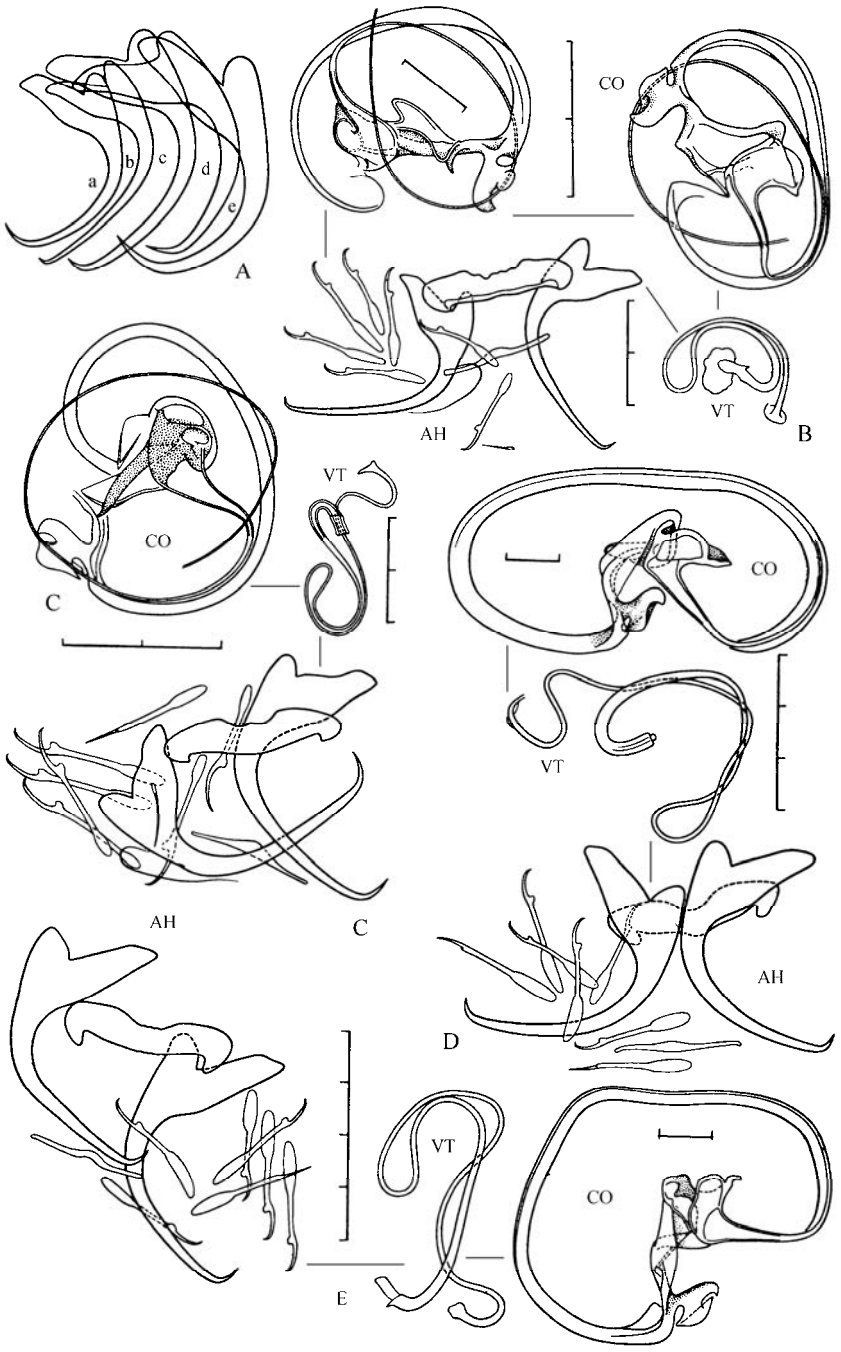
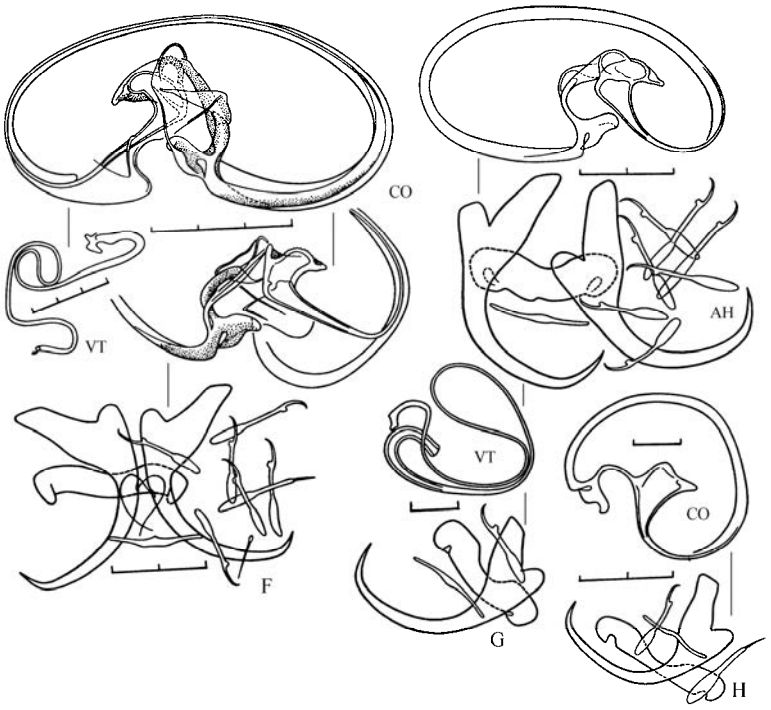
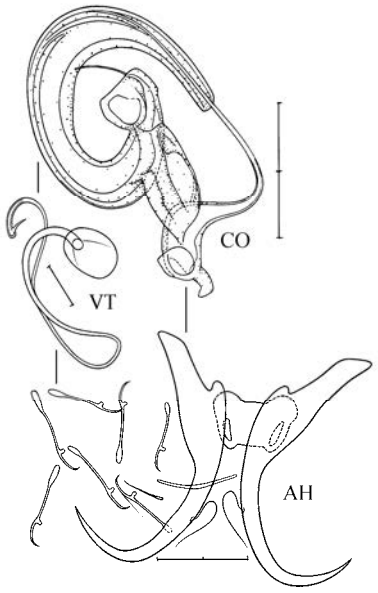


Fig. 52 - *Dactylogyrus tuba*.
A – variations of anchors form from different host species: a – from ***Leuciscus lehmanni***, b – from ***Leuciscus leuciscus***, c – from ***Leuciscus idus***, d – from ***Aspius aspius***, e – from ***Aspiolucius esocinus***; B - specimen from ***Leuciscus leuciscus***, Tisa River (Ukraine); C – specimen from young fish of ***Leuciscus idus***, Lake Seliger, Volga River (Russia); D - specimen from ***Leuciscus idus***, Lake Alol', Pskov region (Russia); E – specimen from ***Leuciscus leuciscus***, Iriklinskoye Reservoir, Volga River (Russia).



53



54

Fig. 53 – 54.
53 - *Dactylogyrus tuba*. F – specimen from *Aspius aspius*, Tisa River (Ukraine); G – specimen from *Aspiolucius esocinus*; H – specimen from *Leuciscus lehmanni*. **54 -** *Dactylogyrus chondrostomi*, Tisa River (Ukraine).

84 (83). The anchors are not longer than 1.5 times the length of the marginal hooks; the ration of length and width of the "wunderi" type bar is 1:5–7.
D. cordus Nybelin, 1937 (Fig. 55)
Syn.: *D. leucisci* Zachwatkin, 1938

These are minute worms; body can be up to 0.5 mm long and 0.13 mm wide. Length of marginal hooks is 0.018–0.024 mm. Length of anchors is 0.032–0.037 mm, main part 0.027–0.031 mm, inner root 0.010–0.014 mm, outer root 0.003–0.006 mm, point 0.009–0.013 mm. Size of dorsal bar is 0.004–0.005 x 0.024–0.030 mm, ventral bar 0.001–0.003 x 0.017–0.019 mm. Total length of copulatory organ is 0.034–0.042 mm, vaginal tube along the curve 0.050–0.070 mm long.

Found on gill filaments of *Leuciscus leuciscus*, *L. l. baicalensis*, *L. lehmanni*, and *Abramis brama* (?). Baltic, Black, and White Sea Basins; water bodies of western Siberia, Lake Baikal, Nura River (Kazakhstan), Zaravshan River (Kuyumazarskoye Reservoir, Uzbekistan). Finds on other fish species (*Vimba vimba* for example) seem to be doubtful.

85 (80). The ventral bar lies across the haptor and has anterior (⊥–shaped) or anterior and posterior (+– shaped) projections.

86 (91). The anchors have an open point ("falcatus" saber-shaped type) without a declinate tip; sometimes a poorly visible bend is present between the point and the main part.

87 (88). The copulatory organ is intermediate between the "nanus" and "chondrostomi" types: the projection of the posterior widening of the accessory piece is directed backwards along the sickle-shaped tube to its initial part; it is short, thin, and claw shaped. The vaginal tube is short; its length is less than 0.025 mm. This is a parasites of *Squalius cephalus.*
D. folkmanovae Ergens, 1956 (Fig. 56)[19]

These small worms are not longer than 0.5 mm, width 0.12 mm. Length of marginal hooks is 0.017–0.032 mm. Length of anchors: dorso-apical 0.027–0.039 mm (ventro-apical length is similar), main part 0.024 –0.035 mm, inner root 0.008–0.015 mm, outer root 0.004–0.005 mm. The point in some cases is not differentiated as it passes into the main part; if it is differentiated its length is 0.005–0.008 mm. Size of dorsal bar is 0.002–0.006 x 0.017–0.027 mm, ventral bar 0.006 (?)–0.011 x 0.015–0.021 mm. Length of copulatory organ is 0.028–0.035 (original description 0.019–0.027) mm, vaginal tube about 0.020 (0.012–0.021?) mm.

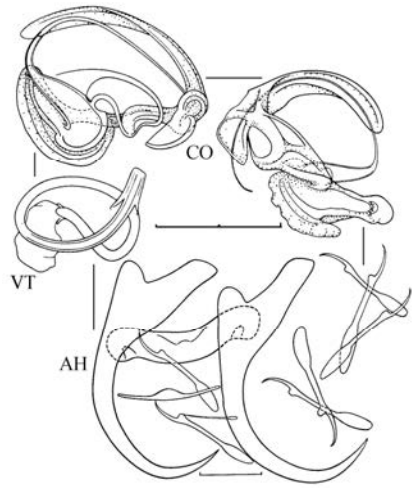
Found on gill filaments of *Squalius cephalus* and *Rutilus rutilus* (?); its area of distribution may be the same as that of its host. It has been found in the Iriklinskoye Reservoir (Ural River, Russia); Danube, Elbe, and Oder Rivers; southern France and England; Lake Skadar (former Yugoslavia).

88 (87). The copulatory organ is of the "chondrostomi" type. The projection of the accessory piece is in the form of a broad tongue-shaped lobe directed backwards along the circle of the curved tube. The length of the vaginal tube is greater than 0.035 mm.

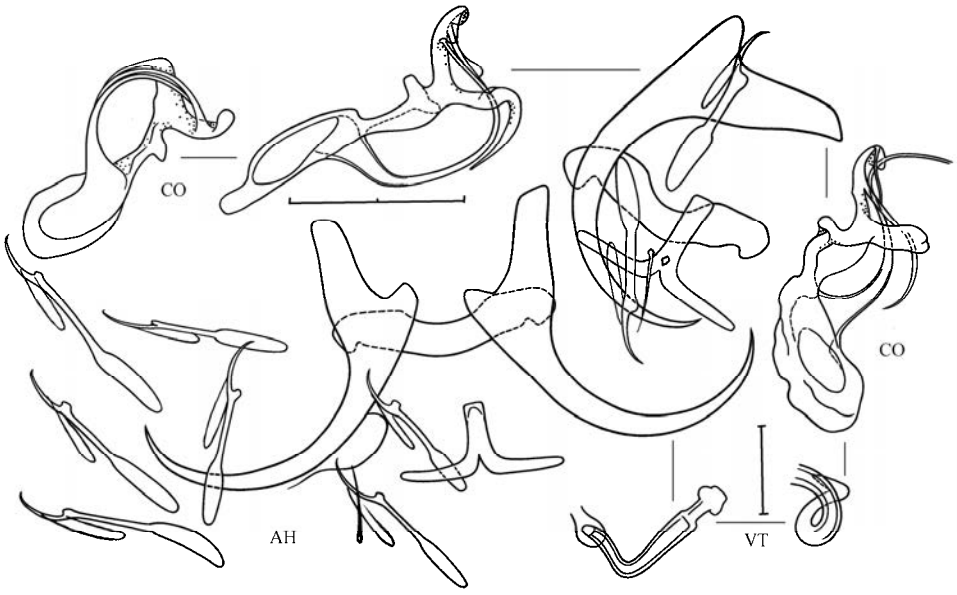
89 (90). The anchors are very thin; their shaft with the point (blade) is nearly 1.5 times longer than the main part with the inner root. The vaginal tube is less than 0.040 mm.
D. elegantis Gussev, 1966 (Fig. 57).

These small worms have a body size up to 0.3 mm long and 0.06 mm wide. Length of marginal hooks is 0.015–0.023 mm. Length of the anchors: dorso-apical 0.023–0.028 mm (ventro-apical length is greater), main part 0.021–0.025 mm, inner root 0.005–0.010 mm, outer root 0.002–0.004 mm, ulterior point forms a saber-shaped blade with the shaft. Size of dorsal bar is

[19] See footnote to thesis 239.



55



56

Fig. 55 – 56.
55 - *Dactylogyrus cordus*, from *Leuciscus idus*, Lake Alol', Pskov region (Russia) (on the right - copulatory organ from specimen of Tisa River, Ukraine). **56 -** *Dactylogyrus folkmanovae*, Tisa River (Ukraine).

0.002–0.003 x 0.015–0.019 mm, ventral bar 0.007 x 0.014–0.018 mm. Total length of copulatory organ is 0.024–0.031 mm, vaginal tube about 0.038 mm.

Found on gill filaments of *Chondrostoma nasus*, River Tisa; Lake Scadar (former Yugoslavia) on *C. knerii.*

90 (89). The anchors are massive; the blade is equal to or shorter than the main part with an inner root. Vaginal tube is greater than 0.040 mm.

D. dirigerus Gussev, 1966 (Fig. 58)

These small worms can be up to 0.53 mm long and 0.11 mm wide. Length of marginal hooks is 0.021–0.035 mm. Length of anchors: dorso-apical 0.030–0.038 mm, main part 0.024–0.030 mm, inner root 0.012–0.015 mm, outer root 0.003–0.004 mm. The point is straight and not differentiated from the main part. Size of dorsal bar is 0.003–0.004 x 0.024–0.030 mm, ventral bar 0.009–0.012 x 0.020–0.024 mm. Total length of copulatory organ is 0.037–0.042 mm, vaginal tube 0.040–0.053 mm.

Found on gill filaments of *Chondrostoma nasus* and *C. colchicum*; Tisa and Danube Rivers (Czechia), water bodies near Batumi (Georgia); Lake Scadar (former Yugoslavia) on *C. knerii*.

91 (86). The anchors have a bent point that is divided from the shaft by a more or less marked twist ("wunderi" type).

92 (93). The ventral bar in most cases has a short posterior projection in the shape of a trident or fringe.[20] These are parasites of the genus *Chondrostoma*.

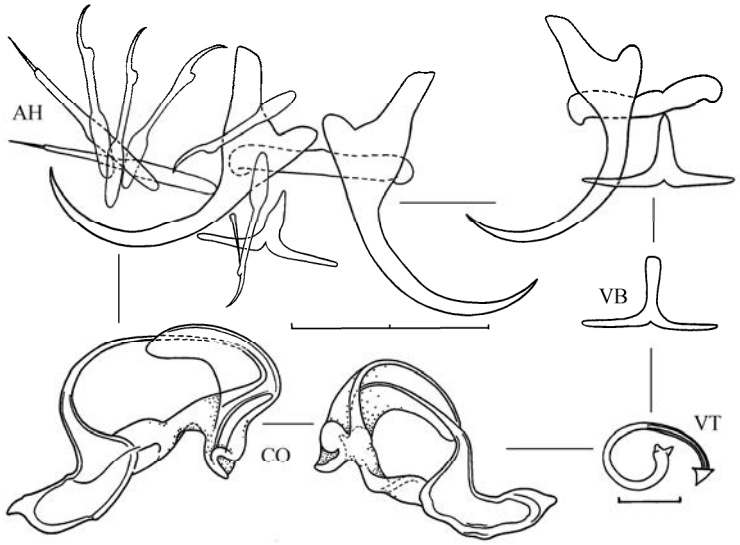
D. ergensi Molnar, 1964 (Fig. 59, 60)

Syn.: *D. nybelini* in Ergens, 1959, part.; *D. chondrostomi* in Kulakowskaja, 1960, part.; *D. elegantis* in Vicente et al., 1975; *Neodactylogyrus dirigerus* in Lambert, 1977; *N. toxostomi* in Lambert, 1977

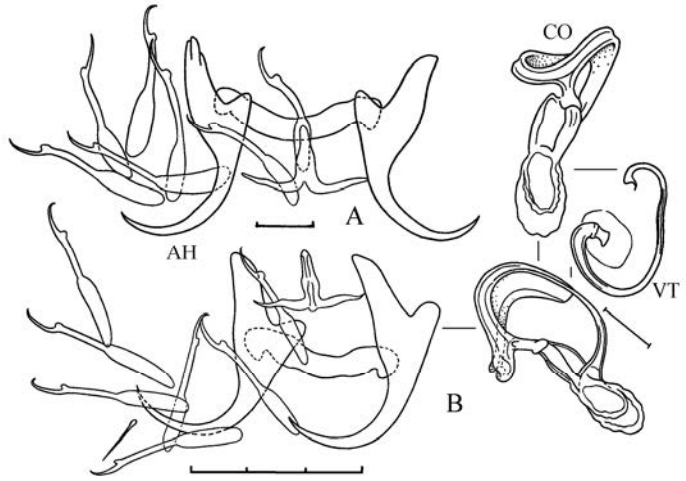
Found on gill filaments of *Chondrostoma nasus*, *C. kubanicum*, and *C. oxyrhynchum*; rivers of the Black and Caspian Sea Basins; Oder and Elbe Rivers (Czechia and Slovakia); in former Yugoslavia on *C. kneri*; in Spain on *C. polylepis*; in southern France on *C. nasus*.

The literature and original data show great variability of the chitinoid structures (size, shape, and ratio of different parts). Two or even three forms with small, large, and medium chitinoid structures (Gussev, 1966b) have been proposed. Unfortunately, not much new material has been gathered after Gussev's publication. Only data from Ergens (1970), Vicente et al. (1975), and Lambert (1977a) have been added, but these data have not clarified the taxonomic status of the different forms. The new species described by Lambert (1977a) as *D. toxostomi* has yet to be validated. It is very similar to the small form noted by Gussev (1966b) as well as to specimens described by Vicente et al. (1975); there are no strict borders between them, and they even overlap by different features. Very high variability of other structures has been noted based on data from the Tisa River (Gussev, 1966b) and by several other authors because anchors were used to distinguish the three forms mentioned above. Based on these features, such specimens can be determined as belonging to other forms. For example the "large" form described by Ergens (1970) can be identified as the "middle size" form based on a number of features, although the length of the vaginal tube is like that of the "large" form. Thus, these three forms are not considered to be valid. However, we provide a table of measurements of these structures and to ask specialists to pay attention to samples of this parasite species from *Chondrostoma*. Features such as body length and width do vary not so strongly (body length is about 0.5 mm and width 0.12 mm). For other data see Table 1.

[20] See also theses 135, 190, 204, 246, 261 and figures of corresponding species.



57



58

Fig. 57 – 58.
57 - *Dactylogyrus elegantis*, Tisa River (Ukraine) (after Gussev, 1966b). **58 -** *Dactylogyrus dirigerus*: A – from the suburbs of Batumi city (Georgia), B – from Tisa River (Ukraine).

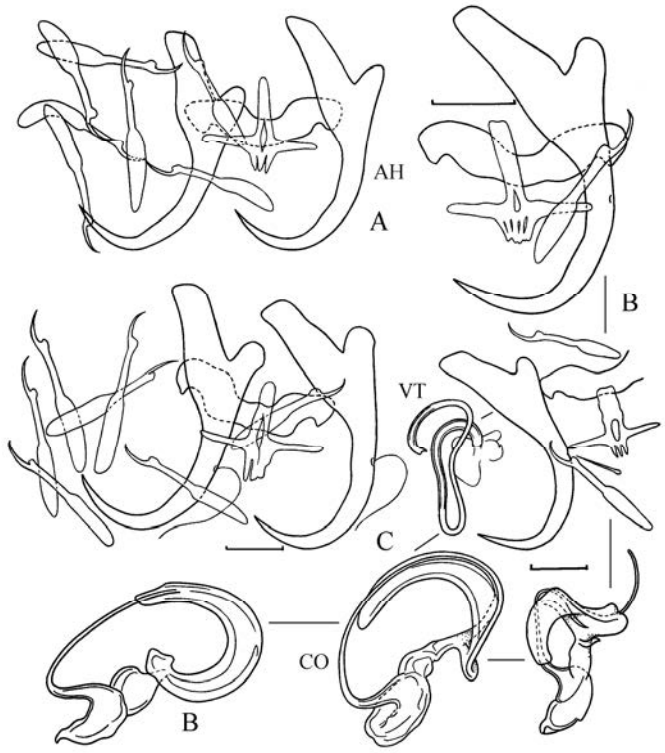


Fig. 59 - *Dactylogyrus ergensi*, "large form".
A – from Volga River (Russia), B - from Tisa River (Ukraine), C – Prut River (Moldova).

93 (92). The ventral bar lacks a posterior projection and usually has a hollow at the posterior edge that juts sometimes rather deeply into the anterior projection. These are parasites of different fish species.

94 (95). The ventral bar is rather massive and has an anterior projection that become broader towards the slightly bifurcated end. These are parasites of *Rutilus frisii* and *R. f. cutum.*
D. nybelini Markewitsch, 1933 (Fig. 61)

Small or medium size worms; body can be up to 0.6 mm long and 0.1 mm wide. Length of marginal hooks is 0.026–0.035 mm. Length of anchors is 0.040–0.052 mm, main part 0.034–0.045 mm, inner root 0.012–0.016 mm, outer root 0.005–0.008 mm, point 0.009– 0.011 mm. Size of dorsal bar is 0.005–0.008 x 0.035–0.040 mm, ventral bar 0.018 x 0.021 mm. Total length of copulatory organ is 0.043–0.050 mm, vaginal tube along the curve 0.085–0.090 mm.

Found on gill filaments *of Rutilus frisii, R. f. cutum,* and *Chondrostoma nasus* (?). Rivers of the Black and Caspian Seas Basins.

95 (94). The dorsal bar is rather thin and the anterior projection is slightly widened and rounded at its end. These are parasites of different fishes.

Table 1. Variability of chitinoid structures of *Dactylogyrus ergensi* (in micrometers).

Structures	"large" form				"Middle" form				"Small" form			
	South Bohemia	Danube River	Tisa and Volga Rivers	Southern France	Danube, Oder, Ural Rivers	Lake Skadar	Southern France	Tisa River	Svitava River	Lake Skadar	Southern France	Spain
references	1	2	3	4	5	6	7	8	9	10	11	12
Anchor length: total	41-43	40-42	38-45	42	33-43	37-39	34	29-33	31-33	30-31	26	22-28
main part	32-34	31-33	29-36	33	23-33	29-31	27	23-26	28-29	22-24	21	20-23
inner root	15-17	16	12-15	13	10-13	12-15	11	10-12	10-12	10-11	9	8-11
outer root	4-6	5-7	3-5	5	3-4	4-5	3	3	3	3-4	2	3-5
point	13-15	12	11-14	12	10-12	11-12	9	9-11	8	10-11	7	8-9
Dorsal bar: length	5-7	5-6	3-6	10	4-5	5	6	22-4	5	4	9	3
width	26	29-31	23-30	27	23-24	22-24	22	18-20	19-20	19-21	15	15-20
Ventral bar: length	15-17	13-17	12-19	15	12-13	16-17	10	9-11	-	9-11	9	10-13
width	21-23	14-17	18-22	17	20	18-21	17	16-18	-	16-18	14	17-22
Marginal hooks length	24-28	25-32	24-31	23-28	19-27	19-25	18-25	19-26	18-24	15-23	15-26	20-25
Copulatory organ length	32-40	41-57	30-50	38	30-45	31-34	37	25-37	36	26-28	30	20-35
Vaginal tube length	64	24-28	64-85	85	45-60	75	50	39-60	-	50	70	40

References: 1 – Ergens (1959); 2 – Molnar (1964); 3 – Gussev (1966b); 4 – Lambert (1977a); 5 – data of different authors; 6 – Ergens (1970); 7 – Lambert (1977a) (*N. "dirigerus"*); 8 - Gussev (1966b); 9 – Lucky (1957); 10 – Ergens (1970); 11 – Lambert (1977a) (*N. "toxostomi"*); 12 – Vicente et al. (1975).

96 (99). The anchors have a well-developed inner root; it is 2.5–3 times longer than the outer root. These are parasites of fishes of genera *Squalius* and *Telestes*.

97 (98). The vaginal tube is coiled and about 0.045 mm long. This is a parasite of *Squalius cephalus.*

D. naviculoides Ergens, 1956 (Fig. 62).

These are small worms; body can be up to 0.5 mm long and 0.09 mm wide. Length of marginal hooks is 0.019–0.024 mm. Length of anchors is 0.040–0.042 mm, main part 0.035– 0.037 mm, inner root 0.016–0.017 mm, outer root 0.004–0.008 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.003–0.004 x 0.028–0.030 mm, ventral bar 0.013–0.014 x 0.019– 0.024 mm. Total length of copulatory organ is 0.030–0.034 mm, vaginal tube along the curve about 0.045 mm.

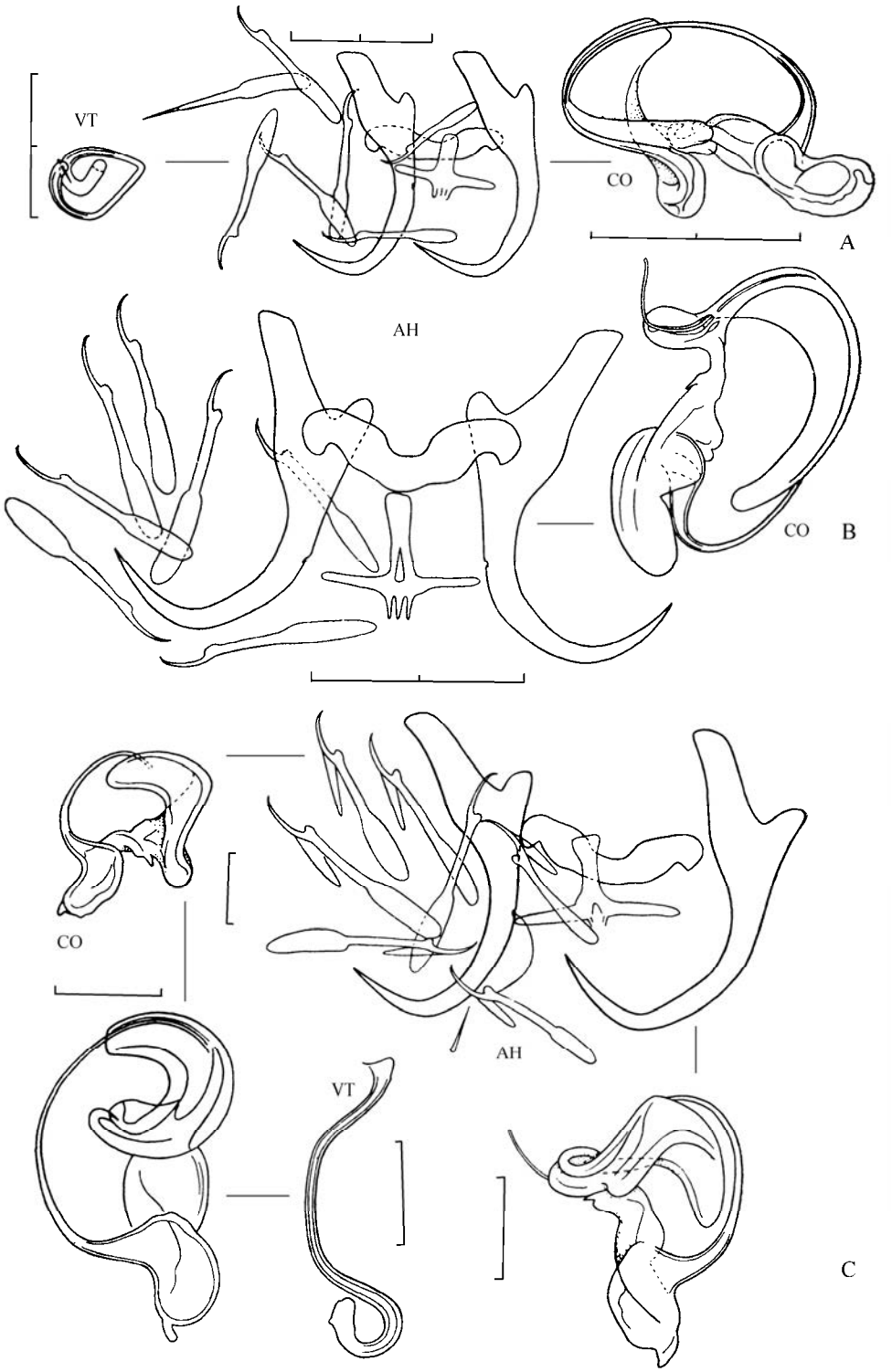
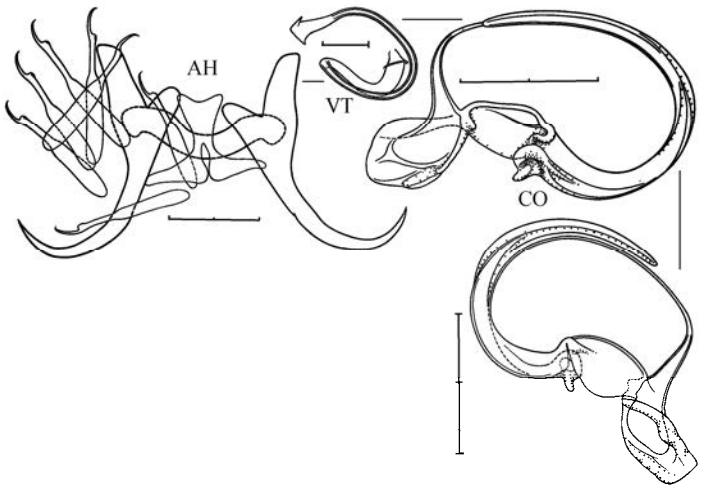
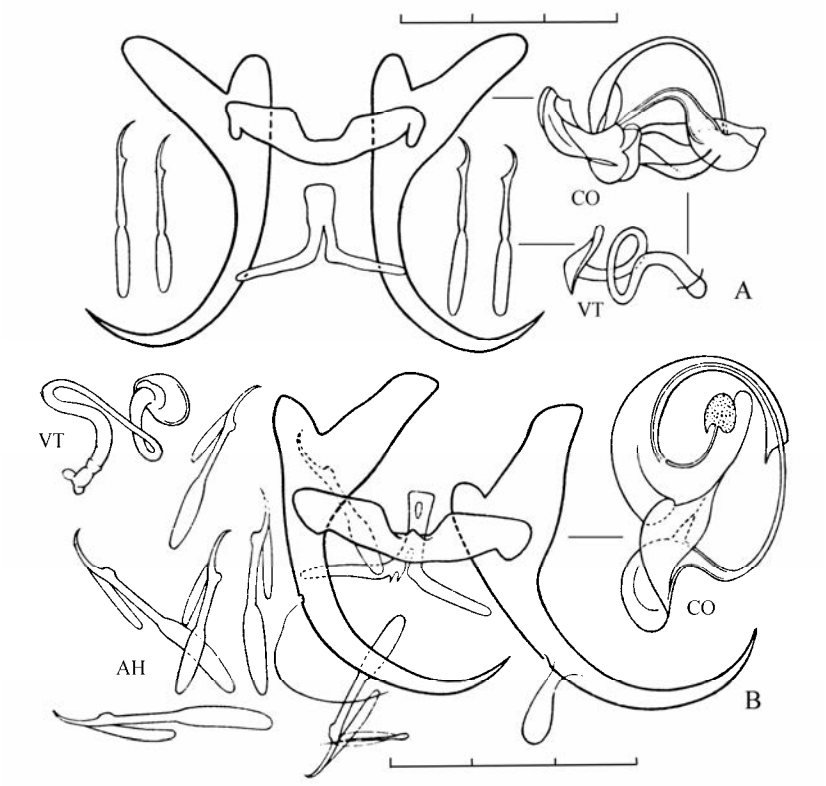


Fig. 60 - *Dactylogyrus ergensi*, "small form":
A - Prut River (Moldova), B – Lukavica River, tributary of Tisa River (Ukraine?), C - from Tisa River (Ukraine?).



61



62

Fig. 61 – 62.
61 - *Dactylogyrus nybelini*, from *Rutilus frisii*, Seret River (Ukraine?). **62 -** *Dactylogyrus naviculoides*: A – Zeletavka River (Czechia), after Ergens, 1960; B – Vltava River (Czechia).

Found on gill filaments of ***Squalius cephalus***; Danube River (Czechia).

The poor quality of the holotype and the rather schematic drawing of the copulatory organ make the validity of this species rather doubtful. However, in 1983 a specimen of ***S. cephalus*** was caught in the Malshe River (a tributary of the Vltava River near Ceske Budejovice, Czechia), and a specimen of ***D. naviculoides*** was found on its gill. The copulatory organ clearly was of the "chondrostomi" type, similar to that of ***D. dirigerus*** and other species of the same morphological group (Fig. 62, B).

98 (97). The vaginal tube is involute like a flat spiral or coil; its length is about 0.06 mm. This is a parasite of western European species of the genus ***Telestes.***

D. soufii Lambert, 1977 (Fig. 63)

These are small worms; body can be up to 0.5 mm long and 0.10 mm wide. Length of marginal hooks is 0.017–0.027 mm. Length of anchors is 0.035–0.040 mm, main part 0.029– 0.032 mm, inner root 0.008–0.011 mm, outer root 0.003–0.005 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.003–0.005 x 0.020–0.025 mm, ventral bar 0.009–0.012 x 0.019–0.022 mm. Total length of copulatory organ is 0.026–0.036 mm, vaginal tube along the curve about 0.060 mm.

Found on gill filaments of ***Telestes soufia*** and ***Telestes agassizi***; Teresva River (basin of the Tisa River, Ukraine); southern France.

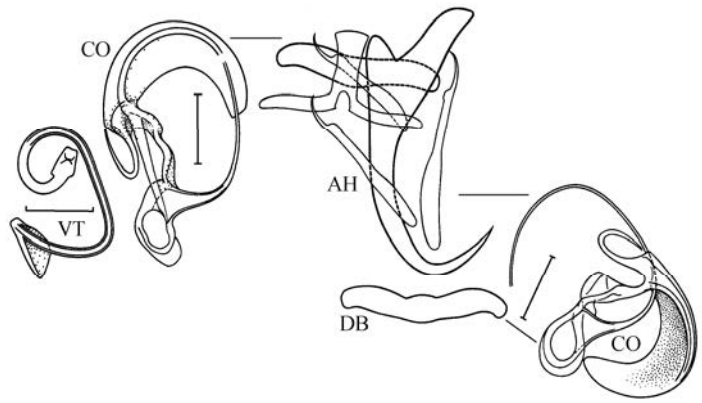
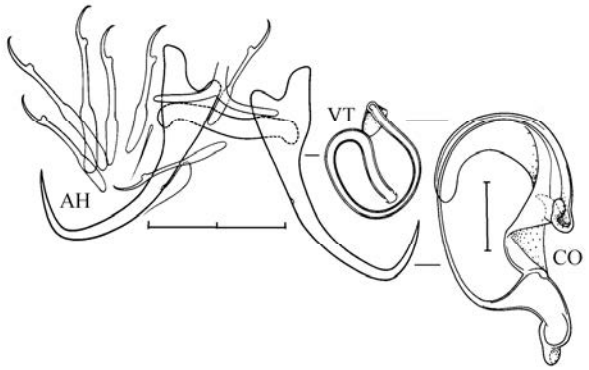


Fig. 63 - *Dactylogyrus soufii*, from Teresva River, tributary of Tisa River (Ukraine).

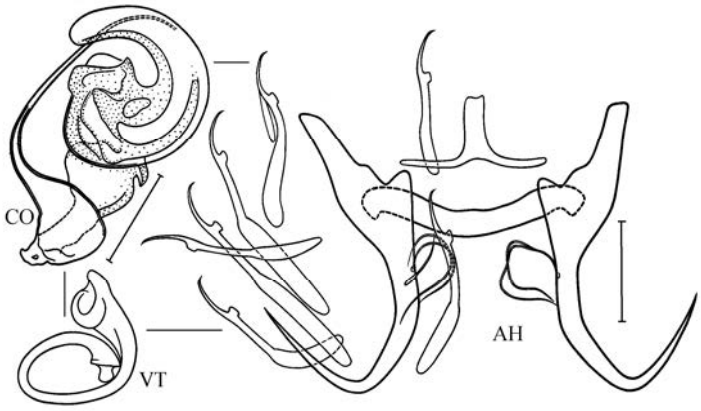
99 (96). The anchors have a poorly developed inner root that is 1.5–2 times longer than the outer root (like the anchors of *D. nanus*). This is a parasite of the genus *Alburnoides*.

D. caucasicus Mikailov et Shaova, 1973 (Fig. 64)

These very small worms have a body length up to 0.3 mm and width to 0.1 mm. Length of marginal hooks is 0.015–0.025 mm. Length of anchors is 0.028–0.035 mm, main part 0.026–0.030 mm, inner root 0.004–0.007 mm, outer root 0.002–0.005 mm, point 0.008–0.009 mm. Size of dorsal bar is 0.003–0.004 x 0.018–0.022 mm, ventral bar 0.007–0.011 x 0.016–0.020 mm. Total length of copulatory organ is 0.038–0.045 mm, vaginal tube about 0.055 mm.



64



65

Fig. 64 – 65.
64 - *Dactylogyrus caucasicus*, Kuban' River (Russia). **65 -** *Dactylogyrus dimitrovae*.

Found on gill filaments of *Alburnoides bipunctatus eichwaldi* and *A. b. rossicus kubanicus*. Mtkvari (Georgia) and Kuban' (Russia) Rivers.

Another species, *D. dimitrovae* Kakacheva - Avramova, 1972, is very similar to *D. soufii* and *D. caucasicus*. It was described from an *Alburnoides* species of Bulgaria and differs from the other species by: 1) a smaller copulatory organ (total length 0.024–0.032 mm) and a shorter vaginal tube (length 0.024–0.038 mm); 2) a slightly different shape of this tube; it also forms a flat spiral, but one end is strongly widened instead of having the cap that is present in the other two species; 3) its anchors have longer inner roots than those of *D. caucasicus*, and the point is of another shape. *D. dimitrovae* has a different host than *D. soufii*.

The anchor length of *D. dimitrovae* is 0.024–0.030 mm, main part 0.020–0.024 mm, inner root 0.006–0.010 mm, outer root 0.002–0.003 mm, point 0.008–0.012 mm. Size of the dorsal bar is 0.002 x 0.018–0.024 mm, ventral bar 0.008 x 0.016 mm (Fig. 65). Unfortunately, the slide of the paratype, which was used to make the drawing, is not of good quality, and this makes it impossible to compare *D. dimitrovae* with the two others species (perhaps *D. caucasicus* is identical to *D. dimitrovae*).

100 (79). The copulatory organ is of another type. The vaginal armament may be present or absent.

101 (105). The ventral bar is triangular in form with a slot or hollow at the anterior edge. Vaginal armament is present.

102 (103). The anchors have a short shaft but a long bent point (not the "wunderi" type). The inner root is as long as the main part and 2–2.5 times longer than the outer root. This is a parasite of *Schizotorax*.

D. longicopula Bychowsky, 1936 (Fig. 66)

These are small worms; body can be up to 0.52 mm long and 0.13 mm wide. Length of marginal hooks is 0.019–0.026 mm. Length of anchors is 0.035–0.043 mm, main part 0.022– 0.027 mm, inner root 0.020–0.028 mm, outer root 0.006–0.011 mm, point 0.018–0.023 mm. Size of dorsal bar is 0.006–0.010 x 0.035–0.047 mm, ventral bar 0.007–0.010 x 0.015–0.020 mm. Total length of copulatory organ is 0.037–0.055 mm, vaginal tube about 0.030 mm (in Bychowsky (1957b) up to 0.040 mm).

Found on gill filaments of *Schizothorax intermedius*, *S. pseudaksaiensis*, and *S. argentatus*; water bodies of Kazakhstan and Central Asia. In several cases (perhaps found accidentally) on *Capoeta capoeta heratensis* from the Kattakurganskoye Reservoir (Uzbekistan).

103 (104). The anchors have a long shaft and a short bent point (not the "wunderi" type). The inner root is more than four times shorter than the main part and is as long as the outer root. These are parasites of fishes of genera *Diptychus* and *Gymnodiptychus*.

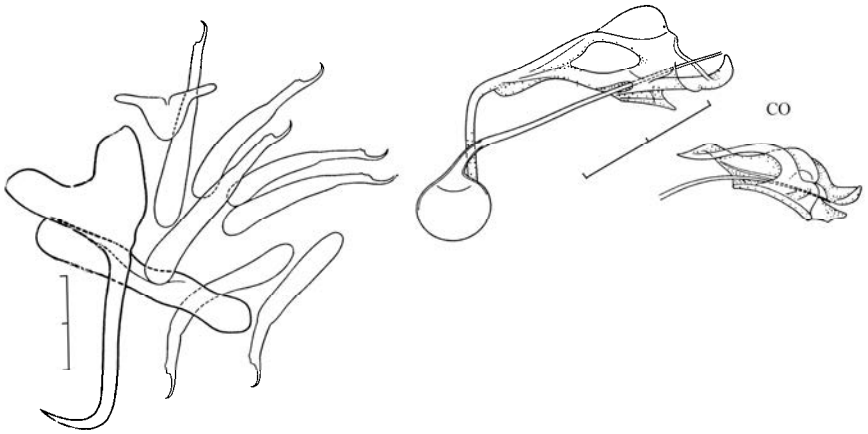
D. drjagini Bychowsky, 1936 (Fig. 67)

These small worms have a body length up to 0.4 mm and width to 0.1 mm. Length of marginal hooks is 0.032–0.045 mm. Length of anchors: dorso-apical 0.055–0.060 mm, ventro–apical 0.057–0.065 mm, main part 0.048–0.051 mm, inner root 0.010–0.013 mm, outer root 0.010–0.012 mm, point 0.012–0.014 mm. Size of dorsal bar is 0.006 x 0.040–0.050 mm, ventral bar 0.010–0.011 (in original description: 0.010–0.018) x 0.018–0.024 mm. Length of copulatory organ is 0.032–0.048 mm, vaginal tube about 0.030 with end bubble 0.010 mm long.

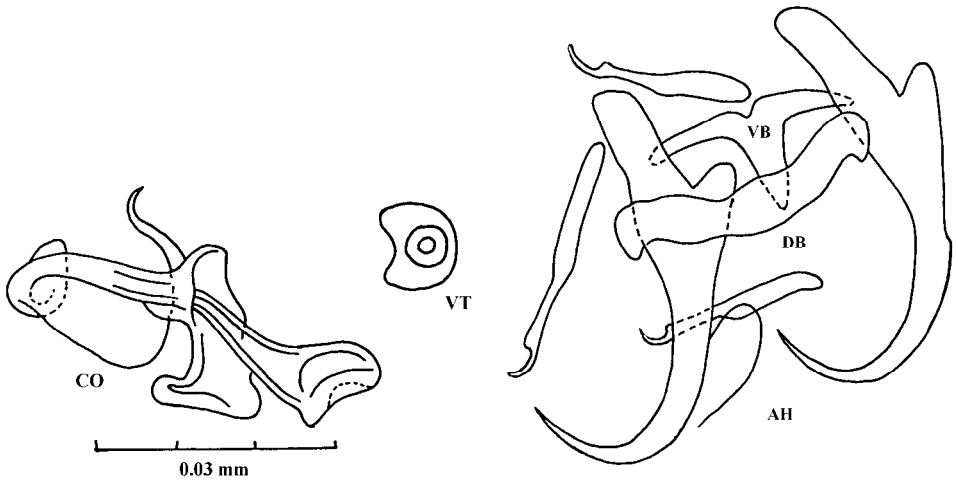
Found on gill filaments of *Gymnodiptychus dybowskii* and *Diptychus maculatus*; water bodies of Kazakhstan; Aral Sea Basin.

104 (105). The anchors are of the "wunderi" type. This is a parasite of *Barbus lacerta.*

66



67



68

Fig. 66 – 68.
66 - *Dactylogyrus longicopula* from Lake Issyk Kul. **67 -** *Dactylogyrus drjagini* from water bodies near Alma-Ata city. **68 -** *Dactylogyrus orbus* (after Gussev et al., 1993a).

D. orbus Gussev, Ali, Abdul-Ameer, Amin et Molnar, 1993 (Fig. 68)

Body length is 0.560 mm, width 0.120 mm. Length of marginal hooks is 0.025–0.035 mm. Length of anchors is 0.052 mm, main part 0.038 mm (all other measurements of different parts of anchors are absent). Size of dorsal bar is 0.008 x 0.039 mm, ventral bar 0.015 x 0.030 mm. Total length of copulatory organ is 0.050 mm, tube diameter in the middle 0.002mm, initial part 0.009 0.010 mm. Vaginal armament is 0.010 mm in diameter.

Parasite of *Barbus lacerta cyri*; Tigris River, near Baiji, Iran.

105 (101). The ventral bar has another shape. The vaginal armament may or may not be present.

106 (110). The anchors have an open point that forms with the shaft a long blade bent only at its end ("falcatus" type of anchors).

107 (108). The ventral bar resembles a transverse stick widened in the middle. The tube of the copulatory organ is thin and sickle shaped; its accessory piece is folded and it supports the tube with short end projections. A vaginal tube is present. This is a parasite of *Squalius cephalus.*

D. vranoviensis Ergens, 1956 (Fig. 69)

These small worms have a body length up to 0.55 mm and width to 0.12 mm. Length of marginal hooks is 0.017–0.025 mm. Length of anchors: dorso-apical 0.035–0.039 mm, ventro-apical 0.040–0.044 mm, main part 0.035–0.038 mm, inner root 0.007–0.010 mm, outer root 0.004–0.006 mm. Size of dorsal bar is 0.003–0.005 x 0.027–0.030 mm, ventral bar 0.002–0.003 x 0.018–0.021 mm. Total length of copulatory organ is 0.032–0.051 mm, tube length along the curve 0.070–0.090 mm, vaginal tube 0.080–0.095 mm.

Found on gill filaments of *Squalius cephalus*; to date it has been found only in basins of the Danube, Oder, and Elbe Rivers.

108 (106). The ventral bar is ⊥ shaped and has a short anterior projection. The copulatory organ is massive and has a sickle-shaped wide tube with a bell–like broadening at its end; the accessory piece envelops the tube of the copulatory organ with two projections (massive, hook-like, and simple). Vaginal armament is absent. This is a parasite of *Abramis brama*.

D. falcatus (Wedl, 1857) (Fig. 70)[21]

Syn.: *D. graciliuncinatus* Alarotu, 1944

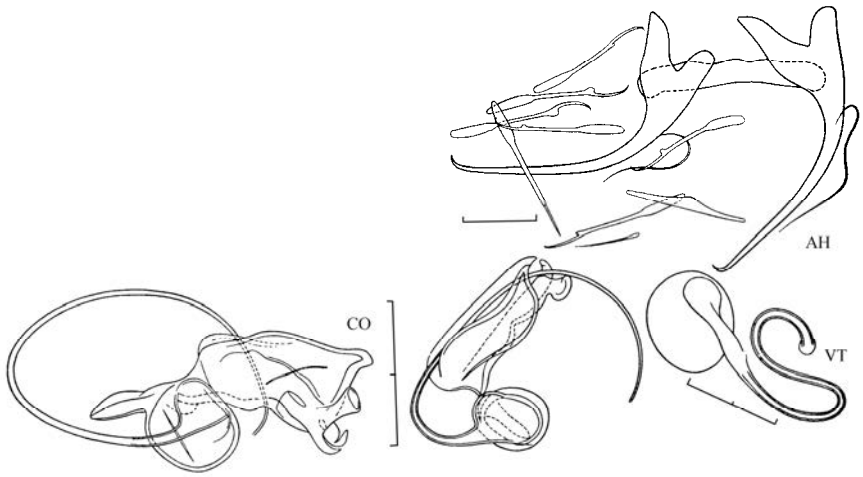
These small or medium size worms have a body length up to 0.9 mm and width to 0.3 mm. Length of marginal hooks is 0.020–0.030 mm. Length of anchors: dorso-apical 0.035– 0.052 mm (from fish 0+ – 3+ up to 0.045 mm, from older fish greater than 0.045 mm), ventro-apical is the same, main part 0.048 mm, inner root 0.012–0.016 mm, outer root 0.002– 0.005 mm. Size of dorsal bar is 0.004–0.005 x 0.031–0.039 mm, ventral bar 0.009–0.015 (with anterior projection) x 0.024–0.030 mm. Total length of copulatory organ is 0.043– 0.065 mm.

Found on gill filaments of *Abramis brama*, *A. b. orientalis*, and *Blicca bjoerkna* (?) (finds on other fish species are occasional). Its distribution coincides with the area of its hosts.

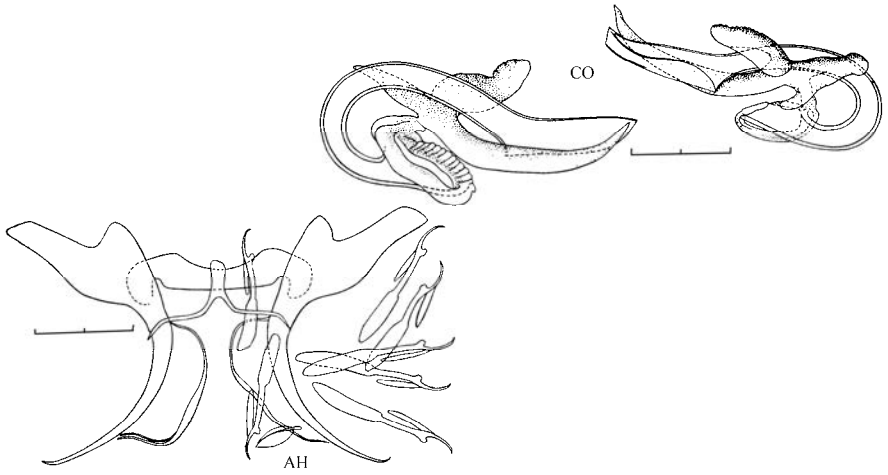
109 (106). The anchors have a bent point that turns into the shaft by a more or less visible bend (anchors are of other types).

110 (174). The ventral bar is stick shaped, usually without projections, and quite often broad in the middle; it lies transverse to or along the haptor.

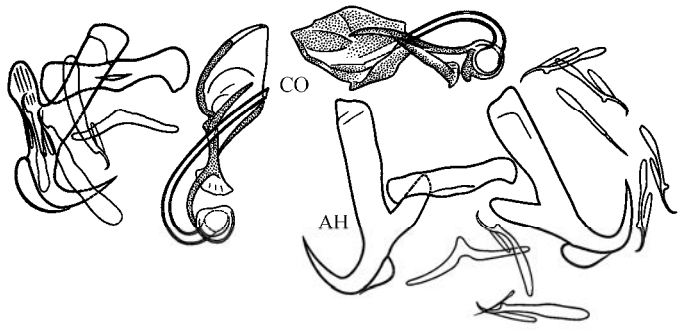
[21] See cl. 1b of Supplement to Palaearctic species of *Dactylogyrus.*



69



70



71

Fig. 69 – 71.
69 - *Dactylogyrus vranoviensis* from Tisa River. **70** - *Dactylogyrus falcatus* from Volga River.
71 - *Dactylogyrus alatus* f. typica from Elbe River.

111 (173). The ventral bar is transverse to the haptor, straight or bent backwards or forwards, and in most cases broader in the middle; the dorsal bar is of the common type.

112 (142). The anchors shaft turns into the point by gradual tapering; the dorsal bar is bent mostly backwards, with a groove at the anterior edge and with widened, posteriorly pointed ends (of the "wunderi" type); in rare cases the dorsal bar is simple and beam shaped with broader ends (of the "vastator" type) or nearly even; the ventral bar is variable in shape.

113 (116). The anchors are massive and have a short main part and well-developed roots, especially the inner one, which is as long as or slightly longer than the main part (of the "sphyrna" type).

114 (115). The length of the anchors is less than 0.045 mm. The length of the copulatory organ is less than 0.050 mm.
D. alatus Linstow, 1878 f. typica (Fig. 71)

These are medium size or large worms; body length can be up to 1.3 mm and width to 0.28 mm. Length of marginal hooks is 0.018–0.030 mm (second pair is longest). Length of anchors is 0.037–0.042 mm, main part 0.019–0.021 mm, inner root 0.022–0.025 mm, outer root 0.010–0.012 mm, point 0.012–0.013 mm. Size of dorsal bar is 0.005–0.008 x 0.027– 0.032 mm, ventral bar 0.003–0.004 x 0.023–0.028 mm. Length of copulatory organ is 0.043– 0.050 mm. Vaginal armament is absent.

Found on gill filaments of *Alburnus alburnus.* Occurrence on *Leuciscus leuciscus, Rutilus rutilus*, and *Leuciscus idus* most likely can be ascribed to *D. alatus* f. major. Finds on *Abramis brama* and *Blicca bjoerkna* are accidental. Water bodies of Europe and Ob' River (Russia).

115 (114). The length of the anchors is greater than 0.045 mm. The length of the copulatory organ is greater than 0.055 mm.
D. alatus Linstow, 1878 f. major Sidorov, 1956 (Fig. 72)

These are medium size or large worms; body length can be up to 1.3 mm and width to 0.3 mm. Length of marginal hooks is 0.020–0.031 mm. Length of anchors is 0.045–0.056 mm, main part 0.024–0.030 mm, inner root 0.027–0.033 mm, outer root 0.012–0.015 mm, point 0.014–0.016 mm. Size of dorsal bar is 0.008–0.010 x 0.038–0.043 mm, ventral bar 0.003–0.004 x 0.020–0.023 mm. Length of copulatory organ is 0.055–0.070 mm. Vaginal armament is absent.

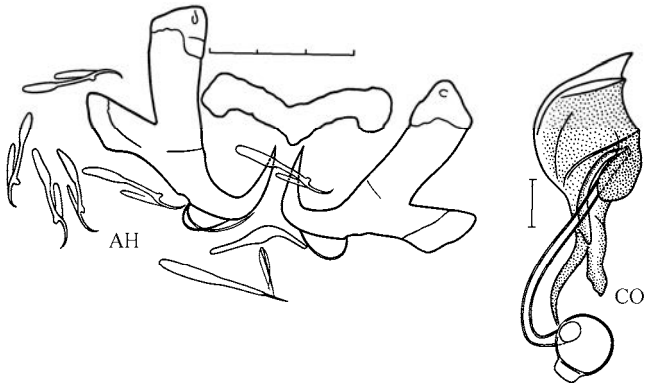
Found on gill filaments of *Leuciscus idus*, *L. i. oxianus*, *L. leuciscus baicalensis*, and *Rutilus rutilus lacustris* (?); water bodies of North Kazakhstan, Ob' and Lena Rivers (Russia).

116 (113). The anchors are rather thin and have a long main part, which is longer than the length of the inner root.

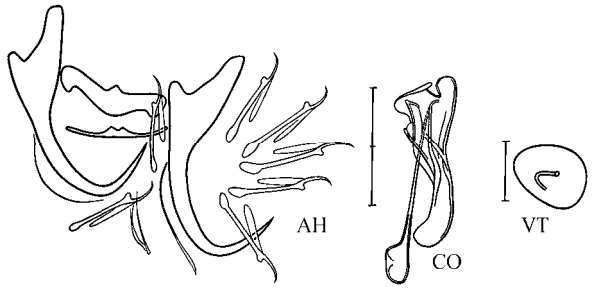
117 (141). The inner root of the anchors is short and not longer than half of the main part. The shape and size of the copulatory organ is highly variable; if the copulatory tube is twisted to form a spiral, then it has fewer than 3–4 spires and is less than 0.065 mm long (if the tube is loop shaped, then it is up to 0.15 mm long).

118 (139). The copulatory organ usually has a short tube (less than 0.065 mm long and only in one case up to 0.125 mm). If present, the vaginal armament resembles a short tube or a plate. These are parasites of different fishes.

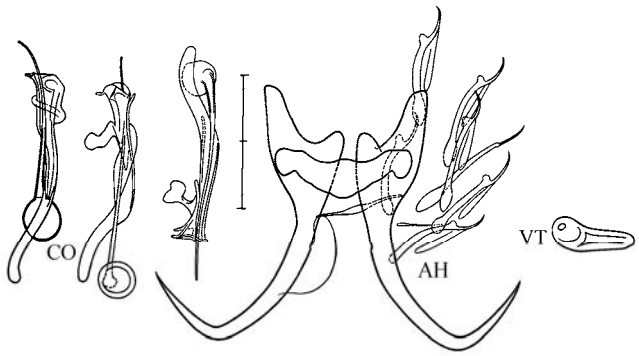
119 (136). The tube of the copulatory organ is straight or bent but it is not spiral shaped or loop shaped.



72



73



74

Fig. 72 – 74.
72 - *Dactylogyrus alatus* f. major from Ob' River. **73 -** *Dactylogyrus meridionalis* – typical form from *Triplophysa strauchii* (Lake Issyk Kul'). **74 -** *Dactylogyrus meridionalis* – atypical form from *Triplophysa stoliczkai* (Lake Bulunkul', the Pamirs).

120 (121). The tube of the copulatory organ is nearly straight and narrow; its diameter is less than 0.001 in the middle; its initial part is bubble shaped. The vaginal armament is a short and broad tube. This is a parasite of fishes of the genus *Triplophysa.*

D. meridionalis Bychowsky, 1936 (Fig. 73)

These are small worms; body size can be up to 0.35 mm long and 0.10 mm wide. Length of marginal hooks is 0.016–0.020 mm; their handle is poorly developed; handle of first and second pairs is in the form of bubble at the end of a pivot. Length of anchors is 0.030–0.033 mm, main part 0.024–0.027 mm, inner root about 0.010 mm, outer root 0.002– 0.003 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.004–0.005 x 0.018–0.019 (in Bychowsky, 1936: 0.019–0.022) mm, ventral bar 0.001–0.002 x 0.017–0.018 mm (absent in original description). Length of copulatory organ is 0.026–0.035 mm. Vaginal armament (absent in original description) consists of a thin oval plate and a short tube; length of this structure is less than 0.010 mm.

Found on gill filaments of *Triplophysa stoliczkai*, *T. dorsalis*, and *T. strauchii*; water bodies of Kazakhstan, Tajikistan, Uzbekistan, and Kyrgyzstan.

Several divergent specimens have been found on gills of *T. stoliczkai* from rivers of the Pamir Mountains (Fig. 74). They differ from the typical form in having a larger size and shape of the chitinoid structures: length of marginal hooks is 0.016–0.021 mm, anchors 0.039–0.040 mm, main part 0.032 mm, inner root 0.010 mm, outer root 0.002–0.003 mm, point 0.013–0.014 mm. Size of dorsal bar is 0.006 x 0.021 mm, ventral bar 0.002 x 0.015–0.016 mm. Length of the copulatory organ is 0.036 mm. Vaginal armament (as seen on a poorly smashed specimen) is a short, broad tube that is 0.013 mm long.

Difficulties with this species arise from its similarity to *D. stankovici*. More studies are needed to solve this problem.

121 (124). The tube of the copulatory organ is bent and broad; its diameter in the middle part is greater than 0.0025 mm. Vaginal armament may be present or absent. These are parasites of different Cyprinidae.

122 (123). The anchors are of the “pseudanchoratus” type. The ventral bar is straight.

D. marocanus El Gharbi, Birgi et Lambert, 1994 (Fig. 75).

Average body length in samples from seven barbell species (after El Gharbi et al., 1994) is 0.254–0.361 (general variability 0.201–0.554) mm and average width 0.066–0.092 (0.038–0.085) mm. Length of marginal hooks: I: 0.017 (0.013–0.021) mm, II: 0.018 (0.017–0.020) mm, III: 0.019 (0.015–0.026) mm, IV: 0.022 (0.018–0.022) mm, V: 0.021 (0.020–0.022) mm, VI: 0.022 (0.019–0.023) mm, VII: 0.020 (0.018–0.023) mm. Average total length of anchors in samples is 0.039–0.043 (general variability 0.036–0.051) mm, main part 0.021–0.026 (0.019–0.033) mm, outer root 0.003–0.005 (0.002–0.007) mm, inner root 0.017–0.022 (0.014–0.024) mm, point 0.011–0.013 (0.010–0.016) mm. Average size of dorsal bar is 0.022–0.026 (0.019–0.029) x 0.002–0.004 (0.002–0.005) mm, ventral bar 0.012–0.015 (0.011–0.017) x 0.001–0.002 (0.001–0.002) mm. Average length of copulatory organ is 0.047–0.053 (general variability 0.038–0.085) mm.

Found on gills of *Labeobarbus fritschii* (type host), *L. reinii*, *Barbus harterti*, *B. paytonii*, *Luciobarbus setivimensis*, *L. nasus*, and *L. ksibi*; Morocco.

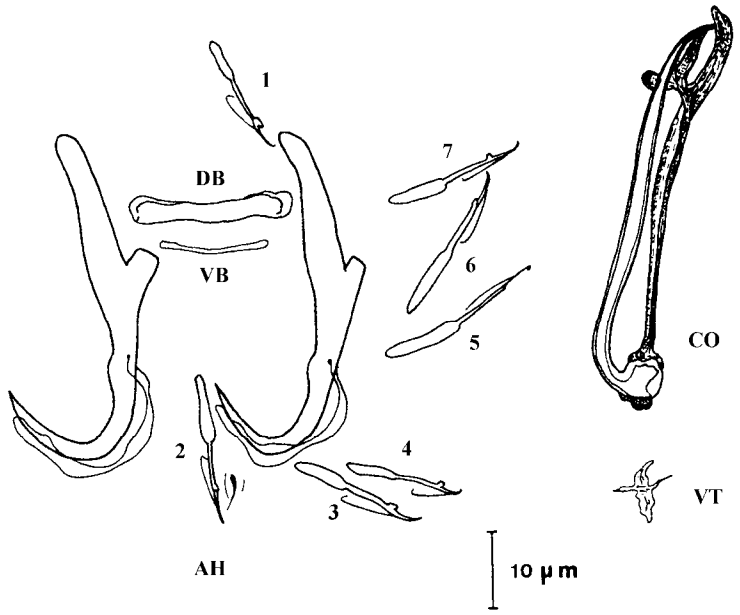
123 (122). The anchors are of the “pseudanchoratus” type. The ventral bar is bent.

D. eslamii Jalali, Shamsi et Molnar, 2000 (Fig. 76)

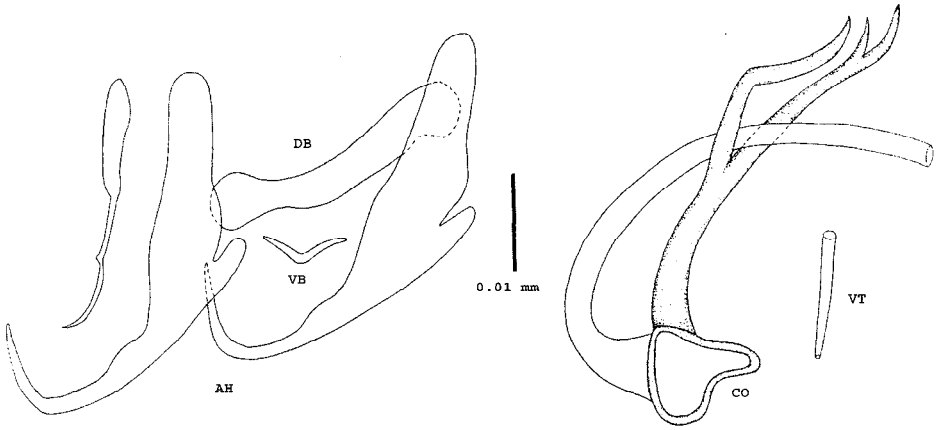
Body length is 0.353 (0.246–0.440) mm and width 0.058 (0.029–0.096) mm. Total length of marginal hooks is 0.020 (0.014–0.026) mm. Length of anchors: dorso-apical 0.035 (0.034–0.036) mm, ventro-apical 0.026 (0.025–0.027) mm, outer root 0.003 (0.003–0.004) mm, inner root 0.016 (0.015–0.017) mm, point 0.009 (0.008–0.009) mm. Size of dorsal bar is 0.003 x 0.019 (0.016–0.021) mm, ventral bar 0.001 x 0.006 (0.005–0.008) mm. Total length of copulatory organ is 0.031 (0.029–0.037) mm. Length of vaginal armament is 0.009 (0.008–0.010) mm and diameter is 0.001mm.

Parasite of *Crossocheilus latius;* from Bahu-Kalat River, close to the city of Pishin, Mokran Basin, Iran.

124 (129). The tube of the copulatory organ is gaunt **S** (or reverse **S**)-like, with thick walls and a massive supporting projection in its initial part; the accessory piece is of the "anchoratus" type. These are large worms; up to 1.5 mm long.

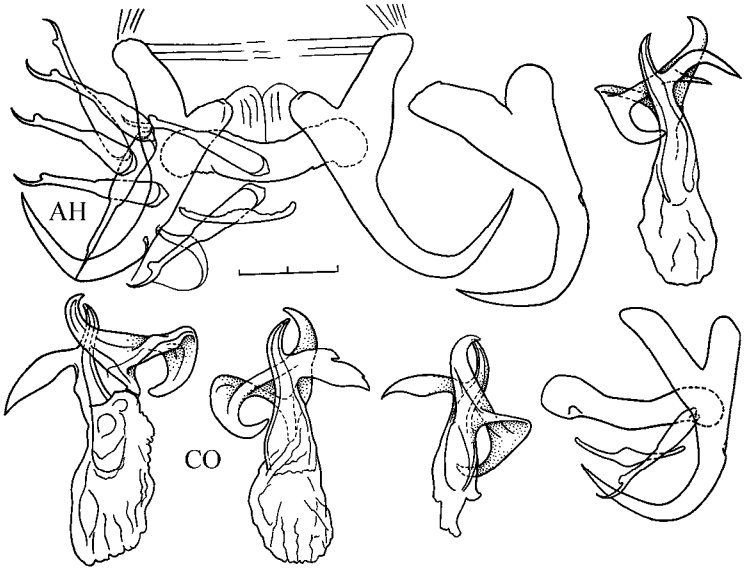


75

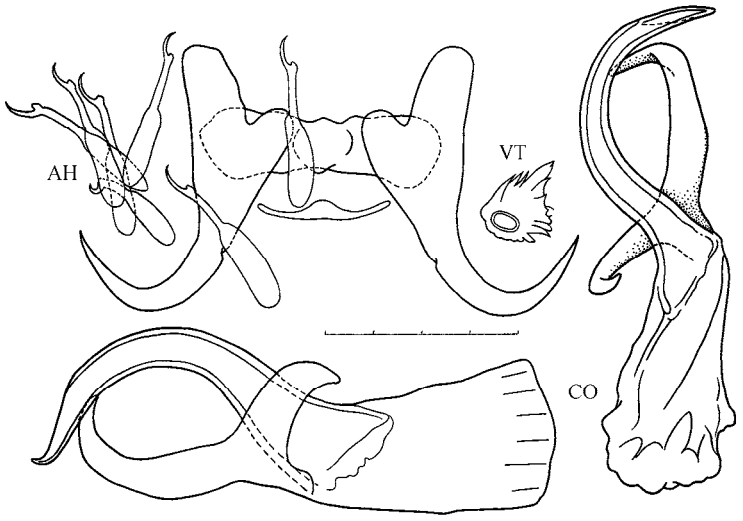


76

Fig. 75 - 76.
75 - *Dactylogyrus marocanus* (after El Gharbi et al., 1994). **76 -** *Dactylogyrus eslamii* (after Jalali et al., 2000).



77



78

Fig. 77 – 78.
77 - *Dactylogyrus macracanthus* from Tisa River. - **78 -** *Dactylogyrus tincae* from Dniester River.

125 (126). The total length of the copulatory organ can be up to 0.065 mm; the tube wall has a long claw-shaped projection. Vaginal armament is absent.
D. macracanthus Wegener, 1910 (Fig. 77)
Syn.: *D. monocornis* Ergens, 1956

These large worms have a body length up to 1.5 mm and width to 0.3 mm. Length of marginal hooks is 0.026–0.040 mm. Length of anchors is 0.046–0.056 mm, main part 0.035– 0.045 mm, inner root 0.015–0.020 mm, outer root 0.005–0.011 mm, point 0.018–0.024 mm. Size of dorsal bar is 0.006–0.012 x 0.039–0.049 mm, ventral bar 0.002–0.004 x 0.019–0.027 mm. Length of copulatory organ is 0.044–0.065 mm.

Found on gill filaments of *Tinca tinca* and *Rutilus rutilus* (?); its distribution coincides with the host area.

126 (127). The total length of the copulatory organ is greater than 0.080 mm; its bent tube lacks a projection. The vaginal pore is surrounded by a small plate. The anterior projection of the accessory piece consists of two parts.
D. tincae Gussev, 1965 (Fig. 78)
Syn.: *D. macracanthus*: in Ergens, 1956

These are large worms; body can be up to 1.5 mm long and 0.4 mm wide. Length of marginal hooks is 0.029–0.036 mm. Length of anchors is 0.049–0.058 mm, main part 0.037– 0.048 mm, inner root 0.017–0.023 mm, outer root 0.008–0.012 mm, point 0.016–0.022 mm. Size of dorsal bar is 0.006–0.010 x 0.039–0.050 mm, ventral bar 0.003–0.004 x 0.021–0.027 mm. Length of copulatory organ is 0.080–0.120 mm. Size of vaginal plate is about 0.012 mm.

Found on gill filaments of *Tinca tinca*; it seems to be distributed throughout its host's area, but to date it has been found only in basins of the Danube and Elbe Rivers.

127 (128). The total length of the copulatory organ is greater than 0.100 mm; its bent tube lacks a projection. The vaginal pore is surrounded by a small plate. The anterior projection of the accessory piece consists of three parts. The ventral bar has a small bulge in the middle and is slightly bent.
D. triappendixis Wierzbicka et Gronet, 1997 (Fig. 79)

Body length can be up to 2.5 mm, width 0.4 mm. Total length of marginal hooks is 0.033–0.039 mm. Total length of anchor is 0.050–0.059 mm, main part 0.038–0.046 mm, outer root 0.006–0.017 mm, inner root 0.017–0.018 mm, point 0.018–0.026 mm. Size of dorsal bar is 0.010–0.017 x 0.045–0.056 mm, ventral bar 0.003–0.004 x 0.024–0.037 mm. Total length of copulatory organ is 0.105–0.126 mm. Size of vaginal armament is 0.006–0.009 x 0.009–0.013 mm.

Found on gills of *Tinca tinca*; Poland.

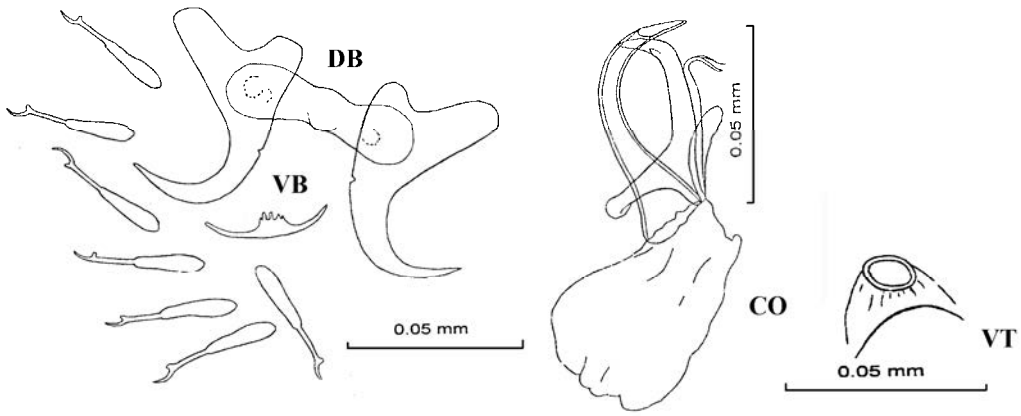


Fig. 79 - *Dactylogyrus triappendixis* (after Wierzbicka and Gronet, 1997).

128 (129). The anchors are slender. The total length of the copulatory organ is less than 0.040 mm. The ventral bar is ⊥ shaped.

D. holciki Molnar et Jalali, 1992 (Fig. 80)

Body length is 0.850 (0.720–0.950) mm and width is 0.110 (0.090–0.126) mm. Total length of smallest marginal hooks is 0.016–0.021, largest one 0.023–0.028. Length of anchors: dorso-apical 0.035 (0.030–0.036) mm, ventro-apical 0.034 (0.028–0.036) mm, main part 0.029 (0.026–0.031) mm, outer root 0.005 (0.004–0.006) mm, inner root 0.010 (0.008–0.012) mm, point 0.009 (0.008–0.011) mm. Size of dorsal bar is 0.003 (0.002–0.004) x 0.026 (0.020–0.031) mm, ventral bar 0.011 (0.010–0.013) x 0.021 (0.016–0.026) mm. Total length of copulatory organ is 0.037 (0.033–0.040) mm. Length of vaginal armament is 0.019 (0.015–0.025) mm.

Found on gills of *Alburnus mossulensis* and *A. chalcoides*; Beshar River, Iran.

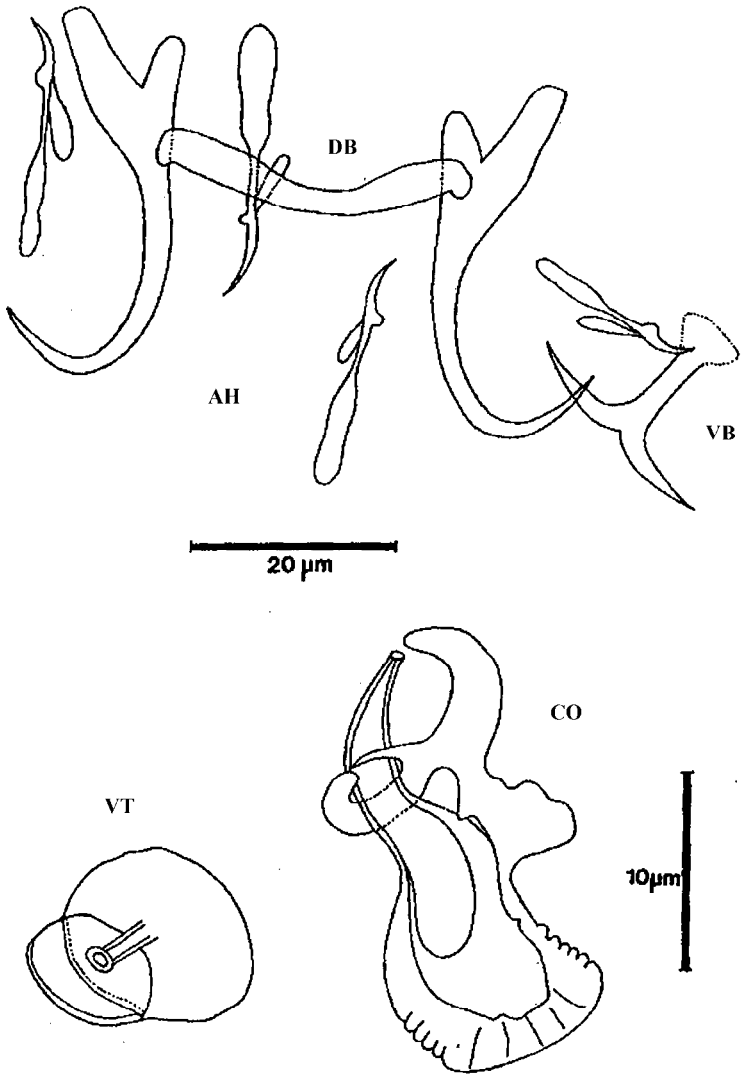


Fig. 80 - *Dactylogyrus holciki* (after Molnar and Jalali, 1992).

129 (124). The tube of the copulatory organ has thin walls and is sickle shaped; the copulatory organ is of the "cryptomeres" type. These are small or medium size worms (less than 0.8 mm long). These are parasites of fishes of the genera *Gobio* and *Romanogobio*.

130 (135). The initial part of the copulatory tube is slightly widened, with a supporting plate of discoid shape. Total length of copulatory organ is greater than 0.030 mm, length of tube along the curve greater than 0.050 mm. The thickness of the ventral bar is greater than 0.003 mm.

131 (134). The ventral bar of the haptor lacks projections in its middle part.

132 (133). All chitinoid structures are very massive; the anchor roots are well developed but not very large; the ventral bar has a very thickened, often saddle shaped, middle part (up to 0.009 mm) and is slightly bent into a **V** shape. Total length of the copulatory organ is greater than 0.040 mm, and the copulatory tube is greater than 0.055 mm long.

D. cryptomeres Bychowsky, 1934 f. typica (Fig. 81)

These are small or medium size worms; body can be up to 0.6 mm long and 0.14 mm wide. Length of marginal hooks is 0.024–0.038 mm. Length of anchors is 0.038–0.053 mm, main part 0.035–0.049 mm, inner root 0.006–0.011 (in Bychowsky, 1934: 0.015) mm, outer root 0.003–0.005 mm, point 0.010–0.014 mm. Size of dorsal bar is 0.007–0.009 x 0.030–0.040 mm, ventral bar 0.004–0.009 x 0.026–0.035 mm. Total length of copulatory organ is 0.040–0.052 mm. Vaginal tube is 0.011–0.020 mm long with a small plate.

Found on gill filaments of *Gobio gobio*, *G. lepidolaemus,* and *Romanogobio albipinnatus*; Lake Beloye (Vologda District, Russia), Danube, Oder, and Ural Rivers, water bodies of Kazakhstan, Uzbekistan, and Bulgaria.

D. cristatus Gussev, 1953 is very similar to the typical form of *D. cryptomeres*. It was described from the basin of the Amur River and differs from *D. cryptomeres* by having more massive chitinoid structures and a crest with a plume-like projection on the accessory piece of the copulatory organ.

The "cryptomeres" group of species from *Gobio* must be revised. The Amur River species of the "cryptomeres" group may be found in different parts of the Palaearctic, having been introduced there with accidentally imported Amur gudgeon species. For example, *Pseudogobio rivularis* with the Amur species of *D. gobioninum* and *D. pseudogobii* have been found in the Keskelenka River near Alma-Ata (Kazakhstan).

133 (134). The chitinoid structures are more delicate; roots of anchors sometimes are poorly visible; the ventral bar of the haptor is nearly straight; its width in the middle is less than 0.004 mm. The length of the copulatory organ is less than 0.036 mm, and the length of its tube along the curve can be up to 0.055 mm.

D. cryptomeres Bychowsky, 1934 f. tisae (Fig. 82)

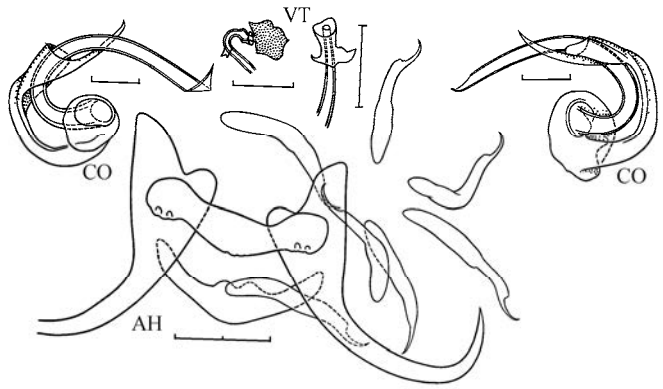
These are small or medium size worms; body can be up to 0.7 mm long and 0.17 mm wide. Length of marginal hooks is 0.027–0.038 mm. Length of anchors is 0.040–0.050 mm. Their shape is highly variable from anchors with well-developed roots (length of inner root 0.010–0.011 mm, outer root 0.005 mm) to those where the roots are not visible. Length of point is 0.009–0.010 mm. Size of dorsal bar is 0.004–0.008 x 0.025–0.032 mm, ventral bar 0.003–0.005 x 0.025–0.030 mm. Length of copulatory organ is 0.032–0.036 mm. Vaginal armament is absent.

Found on gill filaments of *Gobio gobio*; Tisa River (Danube Basin).

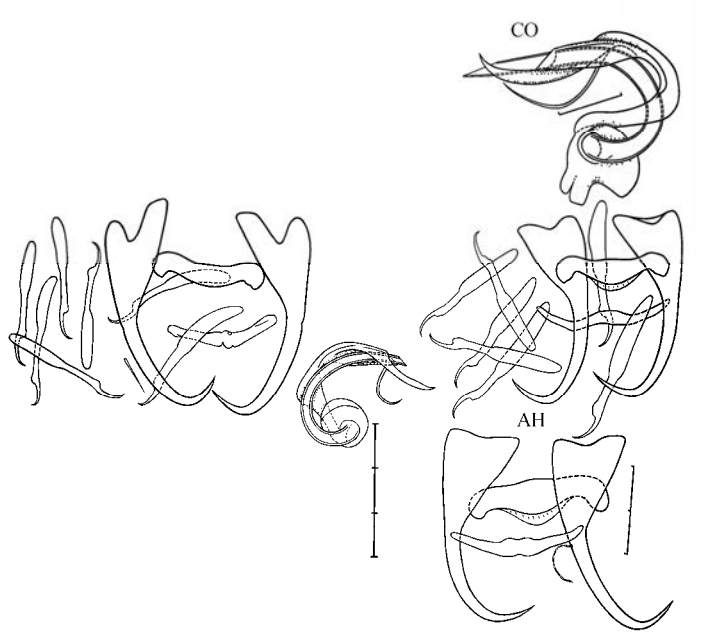
134 (131). The ventral bar in its broader middle part has finger-like projections of irregular shape, small in front and large behind, but they are different than the **+** (or ⊥) shaped bars.[22]

D. finitimus Gussev, 1966 (Fig. 83).

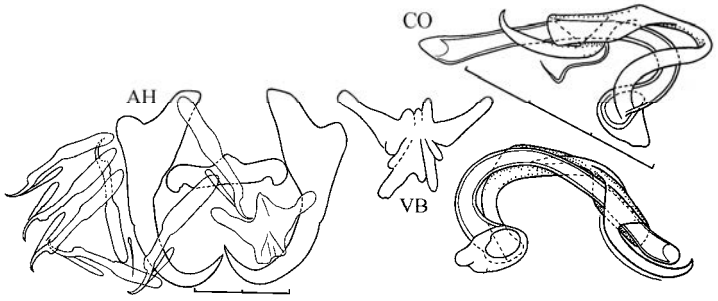
[22] See also theses 92, 190, 204, 246, 261.



81

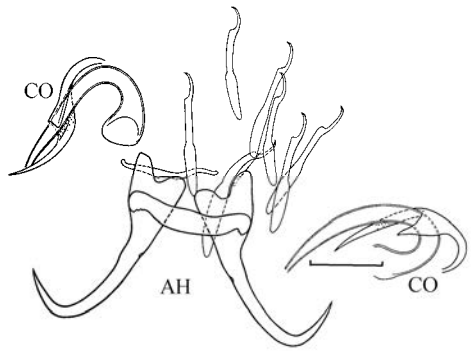


82

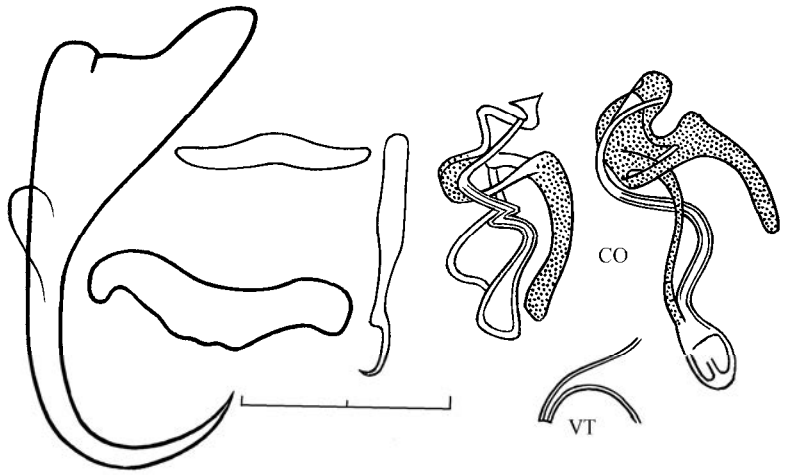


83

Fig. 81 – 83.
81 – *Dactylogyrus cryptomeres* f. typica from *Gobio gobio* (Lake Beloye, Vologda District, Russia). **82 -** *Dactylogyrus cryptomeres* f. tisae from *Gobio gobio*, Tisa River. **83 -** *Dactylogyrus finitimus* from *Gobio gobio*, Tisa River.



84



85

Fig. 84 – 85.
84 - *Dactylogyrus gobii* from *Gobio acutipinnatus*; Lake Markakol' (Kazakhstan). **85 -** *Dactylogyrus modestus* (after Bychowsky, 1957b).

These are small or medium size worms; body length can be up to 0.6 mm and width to 0.15 mm. Length of marginal hooks is 0.022–0.036 mm. Length of anchors is 0.040–0.046 mm, main part 0.031–0.038 mm, inner root 0.010–0.016 mm, outer root 0.002–0.005 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.006–0.008 x 0.026–0.030 mm, ventral bar 0.010–0.015 x 0.020–0.027 mm. Length of copulatory organ is 0.035–0.045 mm. Vaginal armament is absent.

Found on gill filaments of *Gobio gobio* and *Romanogobio vladykovi*; Tisa River.

135 (130). The broadened initial part of the copulatory tube lacks a supporting plate; all chitinoid structures are more delicate; thickness of the ventral bar is less than 0.002 mm. The length of the copulatory organ can be up to 0.030 mm and the length of its tube can be up to 0.040 mm.

D. gobii Gvozdev, 1950 (Fig. 84)

These are very small worms; body can be up to 0.25 mm long and 0.07 mm wide. Length of marginal hooks is 0.022–0.030 mm. Length of anchors is 0.034–0.040 mm, main part 0.029–0.035 mm, inner root about 0.007 mm, outer root 0.004–0.005 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.003–0.004 x 0.022–0.028 mm, ventral bar 0.020–0.024 mm. Length of copulatory organ is 0.022–0.026 mm. Vaginal armament is absent.

Found on gill filaments of *Gobio acutipinnatus*; Lake Markakol' (Kazakhstan).

136 (119). The tube of the copulatory organ is twisted into an extended corkscrew shaped or flat spiral.

137 (138). The length of the anchors is greater than 0.035 mm, and the point is greater than 0.011 mm. The length of the extended spiral-shaped copulatory tube can be up to 0.035 mm. The vaginal tube is nearly straight. This is a parasite of *Schizothorax intermedius.*

D. modestus Bychowsky, 1957 (Fig. 85)

These worms are minute; body can be up to 0.25 mm long and 0.08 mm wide. Length of marginal hooks is 0.021–0.030 mm. Length of anchors is 0.039–0.044 mm, main part 0.034–0.037 mm, inner root 0.009–0.011 mm, outer root 0.004 mm, point 0.012–0.014 mm. Size of dorsal bar is 0.005 x 0.024–0.026 mm, ventral bar 0.003 x 0.018–0.021 mm. Total length of copulatory organ is 0.025–0.030 mm, its tube along the curve 0.035–0.040 mm. The short funnel-shaped vaginal tube is 0.012 mm long.

Found on gill filaments of *Schizothorax intermedius*; Tajikistan and Uzbekistan.

138 (136). The length of the anchors is less than 0.035 mm and the point is less than 0.011 mm. The tube of the copulatory organ is about 0.066 mm long and forms a flat spiral of 1.5 spires. The vaginal funnel is bent like a snail. This is a parasite of *Alburnoides bipunctatus fasciatus.*

D. tauricus Miroshnichenko, 1978 (Fig. 86)

These are small worms; body can be up to 0.4 mm long and 0.1 mm wide. Length of marginal hooks is 0.014–0.024 mm. Length of anchors is 0.030–0.036 mm, main part 0.027– 0.032 mm, inner root 0.006–0.009 mm, outer root 0.003–0.005 mm, point 0.008–0.011 mm. Size of dorsal bar is 0.002–0.005 x 0.018–0.021 mm, ventral bar 0.002–0.003 x 0.014–0.019 mm. Total length of copulatory organ is about 0.024 mm, length of its tube along the curve about 0.052–0.062 mm.

Found on gill filaments of *Alburnoides bipunctatus fasciatus*; Al'ma River (Crimea, Ukraine).

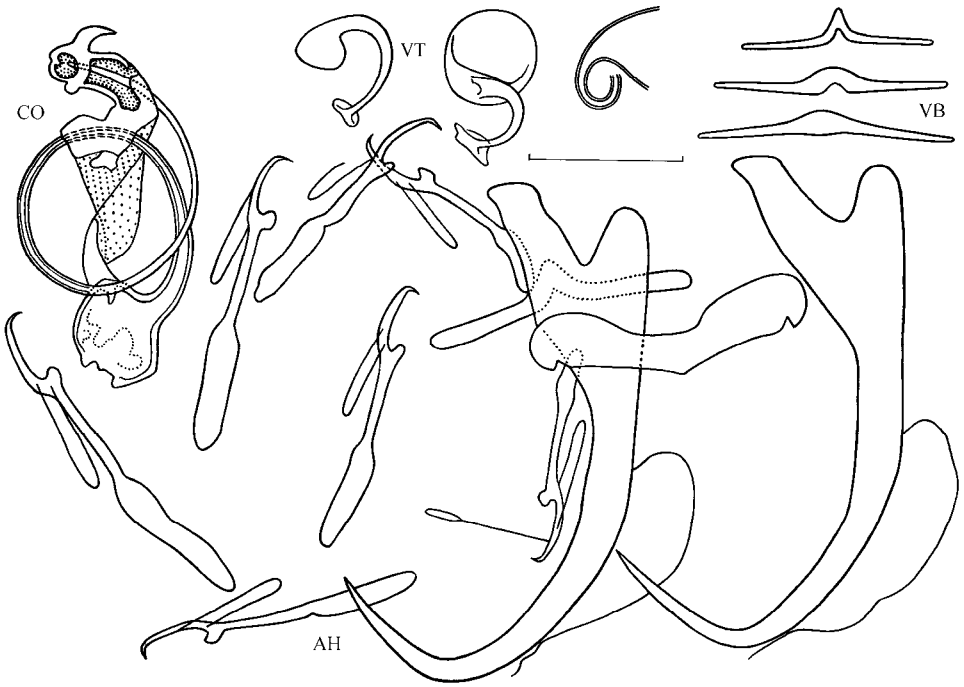
139 (140). The copulatory organ has a very long loop-like twisted thin tube and the vaginal tube is the same length (length along the curve 0.12–0.13 mm and 0.085–0.09 mm, respectively). The ventral bar is less than 0.001 mm long and 0.01 mm wide.

D. rysavyi Ergens, 1970 sensu Gussev, 1985 (Fig. 87)

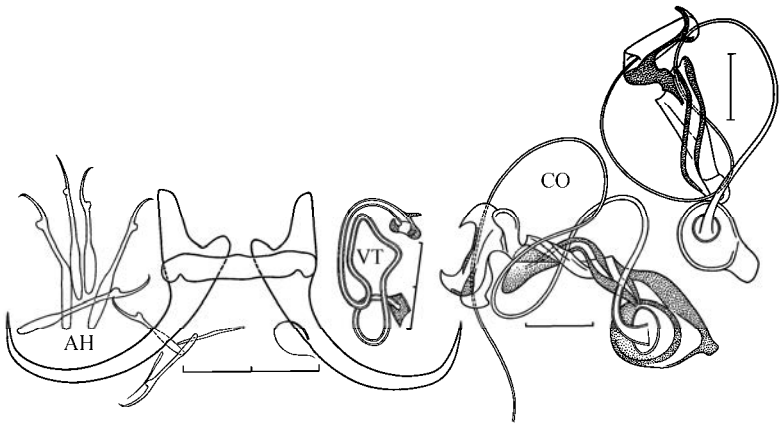
These worms are minute; body length can be up to 0.35 mm and width to 0.07 mm. Length of marginal hooks is 0.013–0.023 mm. Length of anchors is 0.027–0.035 mm, main part 0.024–0.031 mm, inner root 0.007–0.009 mm, outer root about 0.003 mm, point 0.006– 0.008 mm. Size of dorsal bar is 0.003–0.004 x 0.020–0.023 mm, ventral bar 0.001 x 0.010– 0.015 mm. Total length of copulatory organ is

0.030–0.043 mm, length of the copulatory tube along the curve 0.12–0.13 mm. Length of the vaginal tube along the curve is 0.085–0.09 mm.

Found on gills filament of *Aspius aspius*, Rioni River (Georgia).



86



87

Fig. 86 – 87.
86 - *Dactylogyrus tauricus* from *Alburnoides bipunctatus fasciatus*. **87 -** *Dactylogyrus rysavyi* sensu Gussev, 1985 from *Aspius aspius*, Rioni River (Georgia).

140 (118). The length of the tube of the copulatory organ and the vaginal tube along the curve is about 0.14–0.15 and 0.12-0.13 mm, respectively. The ventral bar is in the form of a small thin transversal stick with a bulge in the middle; its length is greater than 0.001 mm and width 0.015 mm.

D. rysavyi Ergens, 1970 (Fig. 88)

Length of marginal hooks is 0.013–0.023 mm. Length of anchors is 0.025– 0.027 mm, inner root 0.007–0.009 mm, outer root about 0.003 mm, point 0.006 mm. Size of dorsal bar is 0.003–0.004 x 0.020–0.021 mm, ventral bar 0.001 x 0.015 mm. Tube of copulatory organ along the curve is 0.14–0.15 mm. Length of the vaginal tube along the curve is 0.12–0.13 mm.

Found on gill filaments of *Alburnoides bipunctatus*; Orakhovshtytza River (former Yugoslavia).

141 (117). The inner root of the anchors is 1.5–1.3 times shorter than the main part. The tube of the copulatory organ has a bubble-shaped initial part; the rest of the tube is narrow and twisted into a right spiral with 6–7 spires; its length can be up to 0.25 mm.

D. pulcher Bychowsky, 1957 (Fig. 89).

Length of marginal hooks is 0.023–0.027 (after Gussev, 1985: 0.019–0.025) mm. Total length of anchors is 0.046–0.047 (0.032–0.040) mm, main part 0.027–0.028 (0.018–0.023) mm, outer root 0.0025–0.003 (0.002–0.003) mm, inner root 0.022–0.023 (0.014–0.018) mm, point 0.013 (0.010–0.011) mm. Size of dorsal bar is 0.005 x 0.023–0.025 (0.002 x 0.014–0.018) mm, ventral bar 0.001 x 0.010–0.012 (0.0007 x 0.008–0.010) mm. Total length of copulatory organ is 0.043 (0.025–0.035) mm, accessory piece 0.033 mm. Length of the tube along the curve is 0.035 mm, diameter 0.001 mm, initial part 0.009 x 0.008 mm. Vaginal armament is 0.18 (0.12) mm long.

Found on skin and gills of *Capoeta capoeta*; Mtkvari (Kura) River, Georgia. Found on gill filaments (mostly at their base) of *Capoeta capoeta steindachneri*; water bodies of Tajikistan, Uzbekistan, and Turkmenistan. Ibragimov (1977) found it on *C. c. heratensis* from the Lenkoran' River and in the upper part of this river on *Barbus lacerta cyri* (Azerbaijan).

142 (112). The shaft of the anchors turns into a point with a sharp-stepped narrowing from the inner side of the anchor; the dorsal bar has an anterior and a posterior groove; the latter is very peculiar (the "varicorhini" type of anchors and bar); the ventral bar is slightly **Ω** shaped.

143 (150). These worms belong to the "varicorhini" group. They are parasites of fish inhabiting water bodies of Transcaucasia and Central Asia.[23]

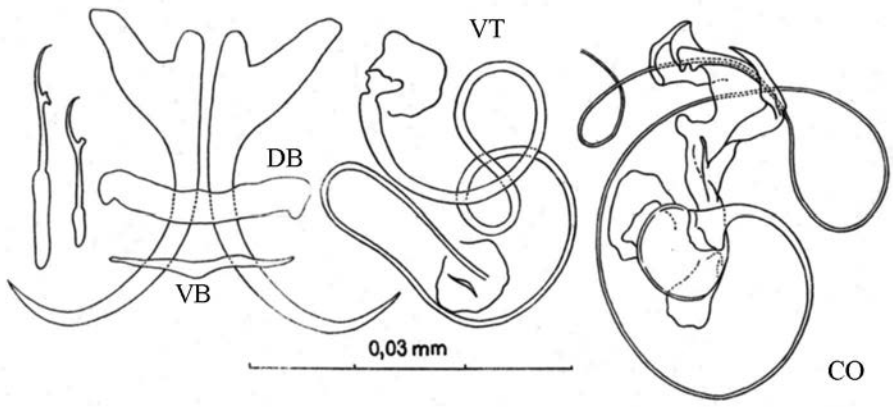
144 (145). The tube of the copulatory organ is very thin (0.001 mm in the middle); the walls also are very thin; the tube has three spires. The vaginal armament is a long tube that is broadened at both ends.

D. varicorhini Bychowsky, 1957 (Fig. 90)

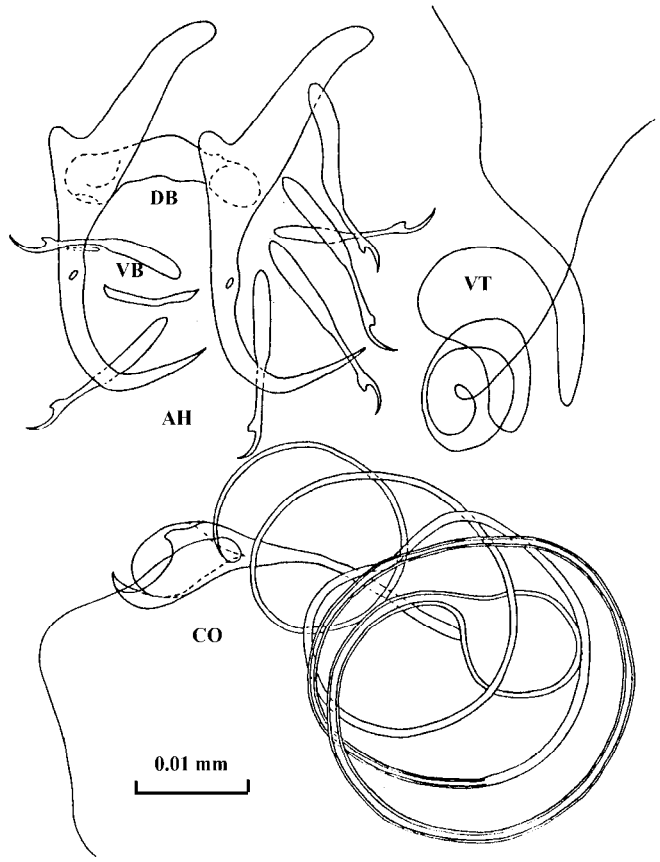
These small or medium size worms have a body length up to 0.56 mm and width to 0.15 mm. Length of marginal hooks is 0.025–0.037 mm. Length of anchors is 0.043–0.049 mm, main part 0.031–0.037 mm, inner root 0.014–0.018 mm, outer root 0.003–0.005 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.007–0.010 x 0.025–0.030 mm, ventral bar 0.002 x 0.023–0.028 mm. Total length of copulatory organ is 0.027–0.035 mm, tube along the curve 0.100–0.125 mm. Length of twisted vaginal tube can be up to 0.060 mm, diameter of seminal receptacle close to 0.030 mm.

Found on gill filaments of *Capoeta capoeta*, *C. c. sevangi*, *C. c. heratensis*, *C. c. steindachneri*, and *C. c. gracilis*; water bodies of Central Asia and Transcaucasia. Paperna (1961) reported it from Israel on gills of *Capoeta damascina* and *Barbus canis*. However, his drawings have

[23] "Varicorhini" morphological group is poorly understood and so authors do not recommend to put a high value on geographical theses but passing through all theses for this group.



88

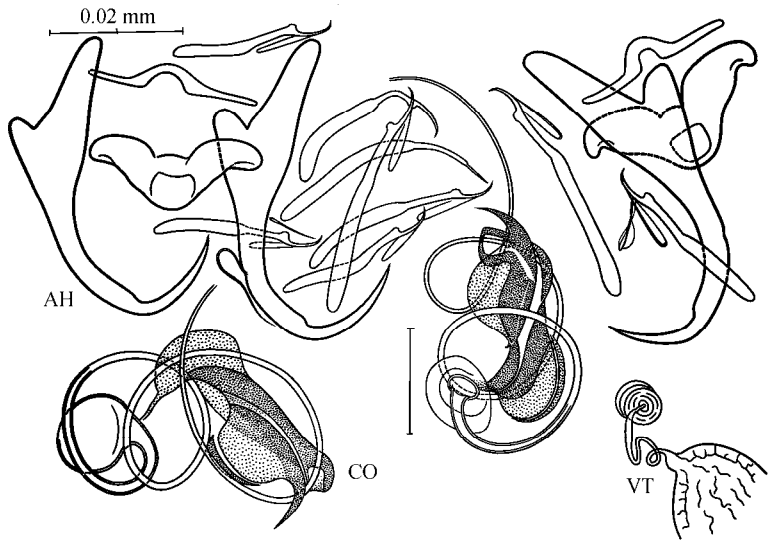


89

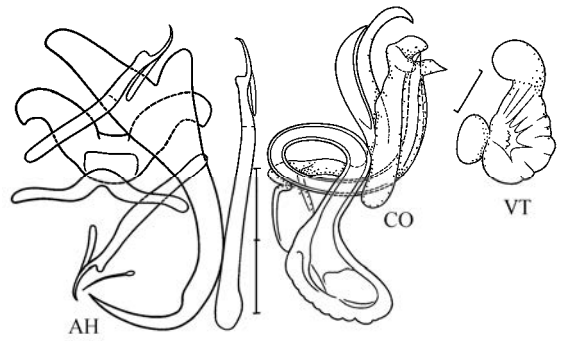
Fig. 88 – 89.
88 - *Dactylogyrus rysavyi* from *Alburnoides bipunctatus* (Orakhovshtytza River, former Yugoslavia) after Ergens, 1970. **89 -** *Dactylogyrus pulcher* from *Capoeta capoeta* (after Matsaberidze, 1991b).

shown that he found not *D. varicorhini*, but another species (perhaps *D. lenkorani* or its "minute" form (*D. araxicus*?) or *D. bocageii* (see next thesis)).

145 (146). The length of the copulatory tube along the curve is greater than 0.075 mm.
D. lenkorani lenkorani Mikailov, 1974 (Fig. 91)



90



91

Fig. 90 – 91.
90 - *Dactylogyrus varicorhini* from *Capoeta capoeta steindachneri*, water bodies of Tajikistan. **91** - *Dactylogyrus lenkorani lenkorani* from *Capoeta capoeta gracilis*; Lenkoran' River, Azerbaijan.

Length of marginal hooks is 0.025–0.040 mm. Total length of anchors is 0.044–0.052 mm, main part 0.031–0.033 mm, outer root 0.006–0.009 mm, inner root 0.015–0.020 mm, point 0.011–0.015 mm. Size of dorsal bar 0.007–0.010 x 0.027–0.035 mm, ventral bar 0.0025 x 0.025–0.030 mm. Length of tube along the curve is 0.075–0.081 mm, diameter 0.003 mm.

Found on gills of *Capoeta capoeta gracilis* and *C. c. sevangi*; Lenkoran' River, Azerbaijan.

146 (147). The length of the copulatory tube along the curve is less than 0.075 but greater than 0.060 mm.

D. kendalanicus Mikailov, 1974 (Fig. 92)

These are medium size worms; 0.68 mm long and 0.17 mm wide. Length of marginal hooks is 0.042–0.052 mm (after Mikailov, 1974: 0.024–0.035) mm. Total length of anchors 0.059–0.063 (0.055–0.058) mm, main part 0.044–0.047 (0.040–0.042) mm, outer root 0.014 (0.009–0.010) mm, inner root 0.020–0.023 (0.016–0.019) mm, point 0.012–0.014 (0.009–0.010) mm. Size of dorsal bar is 0.007-0.020 x 0.034-0.044 (0.009 x 0.038–0.039) mm, ventral bar 0.004-0.005 x 0.047-0.055 (0.004-0.005 x 0.022-0.023) mm. Total length of copulatory organ is 0.036–0.056 (0.044–0.046) mm. Length of the tube along the curve is 0.063–0.073, diameter 0.001–0.002 mm, initial part 0.009–0.011 x 0.012–0.014 mm. The accessory piece consists of 3–4 claw-shaped plates and sometimes a ribbon-like structure that is 0.022–0.028 mm long. Vaginal armament is not found.

Found on gills of *Capoeta capoeta sevangi*; Araks River, Armenia.

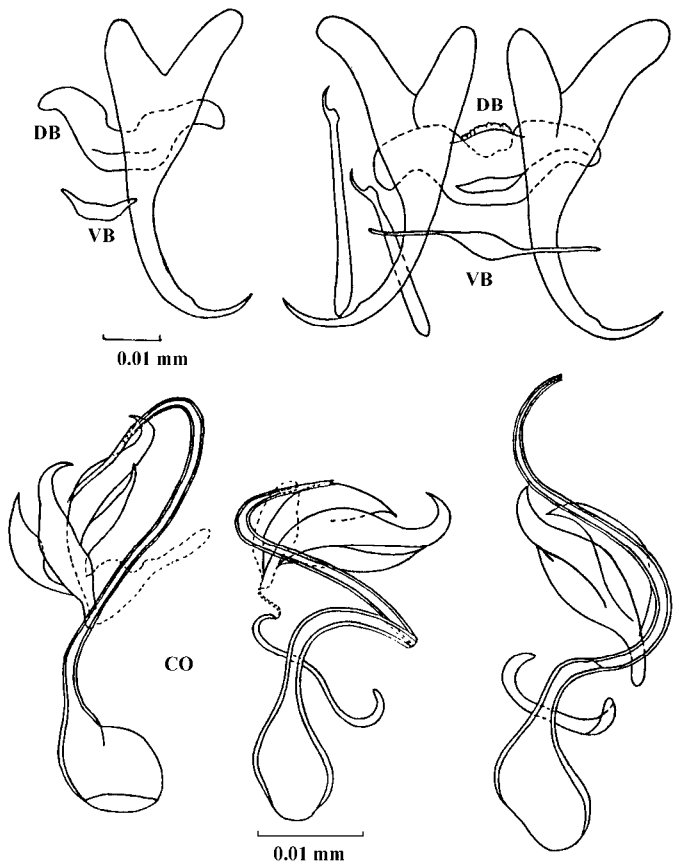


Fig. 92 - *Dactylogyrus kendalanicus* (after Matsaberidze, 1991b).

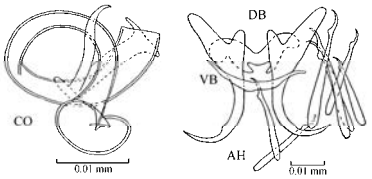
147 (148). The length of the copulatory tube along the curve is less than 0.060 but greater than 0.047 mm.

D. lenkorani araxicus (Mikailov, 1974) (Fig. 93)

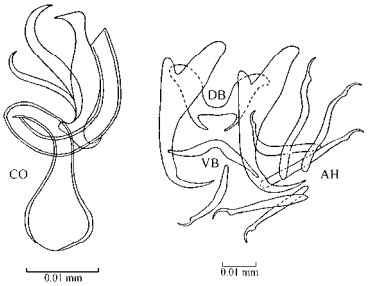
Syn.: *Dactylogyrus araxicus* Mikailov, 1974

Length of marginal hooks is 0.025–0.045 mm. Total length of anchors is 0.043–0.045 mm, main part 0.033 mm, outer root 0.005–0.006 mm, inner root 0.016 mm, point 0.014 mm. Size of dorsal bar is 0.008 x 0.029 mm, ventral bar 0.003 x 0.028 mm. Total length of copulatory organ is 0.023–0.029, accessory piece 0.017 mm. Length of the tube along the curve is 0.047–0.055 mm, diameter 0.0025 mm.

Found on gills of *Capoeta capoeta sevangi*; Lenkoran' River, Azerbaijan.



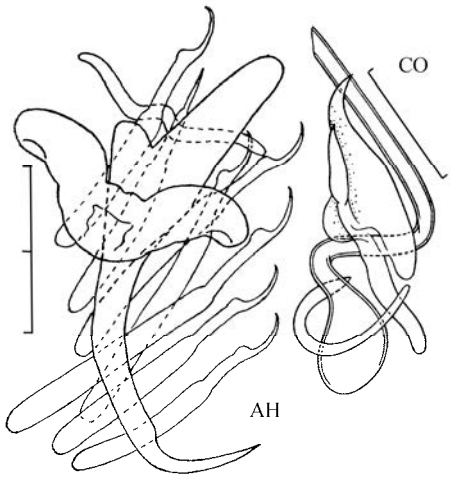
93



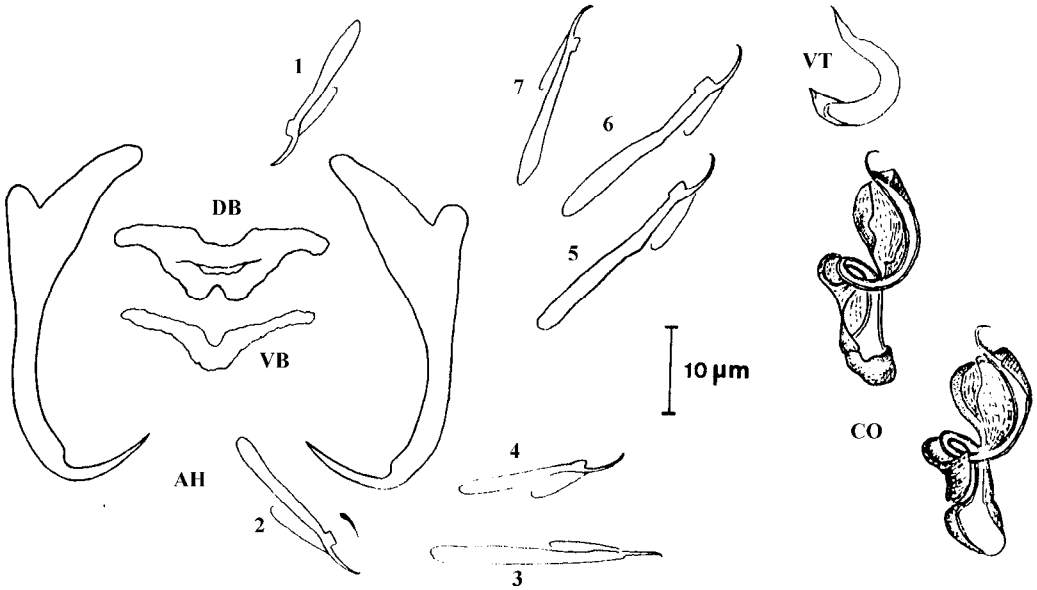
94

Fig. 93 – 94.

93 - *Dactylogyrus lenkorani araxicus* from *Capoeta capoeta sevangi*; Lenkoran' River, Azerbaijan (after Matsaberidze, 1990). **94 -** *Dactylogyrus lenkorani tbilisi* from *Capoeta capoeta* (after Matsaberidze, 1990).



95



96

Fig. 95 – 96.
95 - *Dactylogyrus narzikulovi*. **96** - *Dactylogyrus mascomai.*

148 (149). The length of the copulatory tube along the curve is less than 0.047 but greater than 0.044 mm

D. lenkorani tbilisi Matsaberidze, 1990 (Fig. 94)

Length of marginal hooks is 0.028–0.050 mm. Total length of anchors is 0.050 mm, main part 0.038–0.040 mm, outer root 0.004–0.005 mm, inner root 0.014 mm, point 0.015 mm. Size of dorsal bar is 0.006–0.008 x 0.031–0.033 mm, ventral bar 0.004 x 0.030–0.035 mm. Total length of copulatory organ is 0.029–0.042 mm, accessory piece 0.017 mm, length of the tube along the curve 0.044–0.047 mm, diameter 0.002–0.003 mm.

Found on gills of *Capoeta capoeta*; Mtkvari (Kura) River, Georgia.

149 (148). The length of the copulatory tube along the curve is less than 0.042 mm.

D. narzikulovi Gussev et Dzhalilov, 1984 (Fig. 95)

These are small or medium size worms; body can be up to 0.8 mm long and 0.2 mm wide. Length of marginal hooks is 0.030–0.045 mm. The anchors are of the "varicorhini" type; the outer root is 4–4.5 times shorter than the inner root; length of anchors is 0.048–0.052 mm, main part 0.036–0.040 mm, inner root 0.016–0.017 mm, outer root 0.004 mm, point 0.012–0.013 mm. Size of dorsal bar is 0.009 x 0.030–0.031 mm, ventral bar 0.002 x 0.024–0.026 mm. Length of copulatory organ is 0.026– 0.029 mm, length along the curve of the thin-walled cylindrical tube is 0.038–0.042 mm (it has a spiral with 1.5 spires); diameter of bubble-shaped initial part is 0.005–0.006 mm, middle part about 0.0015 mm. Vaginal armament is not found.

Found on gills of *Capoeta capoeta steindachneri*; Chali-Char-Chashma Pond (Tadjikistan).

150 (158). These worms belong to the “varicorhini” group. They are parasites of fish inhabiting water bodies of the Iberian Peninsula.

151 (152). The accessory piece ends in a wide gutter and looks like a leaf with involute edges.

D. mascomai El-Gharbi, Renaud et Lambert, 1992 (Fig. 96)

Body length is 0.333 (0.274–0.405) mm, width 0.069 (0.068–0.073) mm. Length of marginal hooks: I: 0.022 (0.020–0.024) mm, II: 0.026 (0.024–0.027) mm, III: 0.032 (0.029–0.033) mm, IV: 0.023 (0.022–0.027) mm, V: 0.032 (0.030–0.034) mm, VI: 0.034 (0.032–0.036) mm, VII: 0.029 (0.024–0.036) mm. Length of anchors is 0.042 (0.038–0.045) mm, main part 0.033 (0.030–0.035) mm, outer root 0.005 (0.004–0.006) mm, inner root 0.016 (0.014–0.018) mm, point 0.012 (0.011–0.013) mm. Size of dorsal bar is 0.007 (0.006-0.008) x 0.028 (0.024-0.031) mm, ventral bar 0.004 (0.003-0.005) x 0.027 (0.023-0.029) mm. Length of copulatory organ is 0.026 (0.025–0.028) mm, tube 0.045 (0.041–0.046) mm, accessory piece 0.023 (0.020–0.025) mm. Vaginal armament is a slightly sclerotized tube.

Found on gills of *Luciobarbus guiraonis* and *Barbus haasi*; Spain.

152 (153). The accessory piece consists of two parts that form a very characteristic ring.

D. comizae El-Gharbi, Renaud et Lambert, 1992 (Fig. 97)

Body length is 0.085–0.093 mm and width 0.055–0.078 mm. Length of marginal hooks from the I to VII pair: 0.022, 0.023, 0.025, 0.031, 0.025, 0.032, and 0.28 mm, respectively. Length of anchors is 0.041–0.042 mm, main part 0.029–0.030 mm, outer root 0.004–0.005 mm, inner root 0.015–0.016 mm, point 0.013–0.014 mm. Size of dorsal bar is 0.007 x 0.027 mm, ventral bar 0.004 x 0.022 mm. Length of copulatory organ is 0.029–0.033 mm, tube 0.095–0.108 mm. Vaginal armament is 0.066–0.067 mm long.

Found on gills of *Luciobarbus comizo*; Spain.

153 (152). The distal part of the accessory piece has two projections in the form of a pincer-shaped bifid structure.

154 (155). The distal part of the accessory piece is a pincer-shaped bifid structure. Its length is half the total length of the copulatory organ.

D. guadianensis El-Gharbi, Renaud et Lambert, 1992 (Fig. 98)

Body length is 0.366 (0.250–0.450) mm and width 0.046 (0.030–0.050) mm. Length of marginal hooks from the I to VII pair: 0.021 (0.19–0.022), 0.022 (0.021–0.022), 0.020 (0.017–0.021), 0.029 (0.024–0.033), 0.027 (0.024–0.028), 0.033 (0.030–0.035), 0.026 (0.025–0.027) mm, respectively. Total length of anchors is 0.038 (0.029–0.049) mm, main part 0.028 (0.023–0.038) mm, outer root 0.003 (0.002–0.005) mm, inner root 0.015 (0.010–0.017) mm, point 0.011 (0.009–0.013) mm. Size of dorsal bar is 0.006 (0.004-0.008) x 0.024 (0.019-0.033) mm, ventral bar 0.006 (0.004-0.007) x 0.022 (0.019-0.032) mm. Length of copulatory organ is 0.029 (0.020–0.034) mm, tube 0.055 (0.050–0.061) mm, accessory piece 0.025 (0.019–0.030) mm.

Found on gills of *Luciobarbus comizo* and *L. microcephalus*; Spain.

155 (156). The length of the distal part of the pincer-shaped bifid structure is less than half the total length of the copulatory organ (about 0.010 mm). The length of the copulatory tube along the curve is less than 0.050 mm.

D. doadrioi El-Gharbi, Renaud et Lambert, 1992 (Fig. 99)

Body length is 0.207 (0.150–0.300) mm and width 0.026 (0.020–0.030) mm. Length of marginal hooks from the I to VII pair: 0.018 (0.018–0.020), 0.021 (0.020–0.022), 0.027 (0.025–0.028), 0.020 (0.019–0.020), 0.024 (0.023–0.026), 0.029 (0.028–0.031), 0.025 (0.024–0.027) mm, respectively. Total length of anchors is 0.031 (0.029–0.035) mm, main part 0.026 (0.024–0.028) mm, outer root 0.003 (0.002–0.003) mm, inner root 0.011 (0.010–0.013) mm, point 0.010 (0.009–0.011) mm. Size of dorsal bar is 0.004 (0.003-0.006) x 0.020 (0.017-0.022) mm, ventral bar 0.003 (0.002-0.004) x 0.021 (0.017-0.024) mm. Length of copulatory organ is 0.022 (0.020–0.025) mm, tube 0.041 (0.036–0.047) mm, accessory piece 0.018 (0.017–0.021) mm.

Found on gills of *Luciobarbus comizo* and *L. microcephalus*; Spain.

156 (157). The length of the distal part of the pincer-shaped bifid structure is less than half the total length of the copulatory organ (about 0.010 mm). The length of the copulatory tube along the curve is greater than 0.050 mm. The length of the accessory piece is greater than 0.027 mm.

D. lenkoranoides El-Gharbi, Renaud et Lambert, 1992 (Fig. 100)

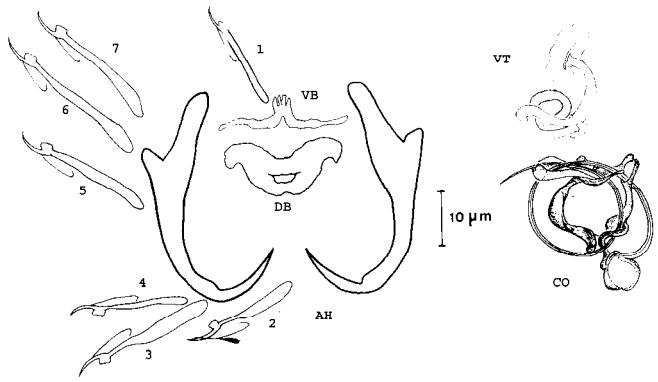
Body length is 0.317 (0.294–0.387) mm and width 0.068 (0.058–0.078) mm. Length of marginal hooks: I: 0.023 (0.018–0.027), II: 0.025 (0.021–0.028), III: 0.035 (0.032–0.036) mm, IV: 0.024 (0.020–0.028) mm, V–VII: 0.029 (0.023–0.041) mm. Length of anchors is 0.038 (0.035–0.044) mm, main part 0.029 (0.025–0.032) mm, outer root 0.004 (0.003–0.004) mm, inner root 0.016 (0.012–0.017) mm, point 0.011 (0.010–0.013) mm. Size of dorsal bar is 0.005 (0.003-0.008) x 0.025 (0.022-0.029) mm, ventral bar 0.003 (0.002-0.006) x 0.026 (0.022-0.030) mm. Length of copulatory organ is 0.034 (0.033–0.043) mm, tube 0.059 (0.051–0.068) mm, accessory piece 0.031 (0.027–0.040) mm.

Found on gills of *Luciobarbus guiraonis*, *L. graellsii*, and *Barbus haasi*; Spain.

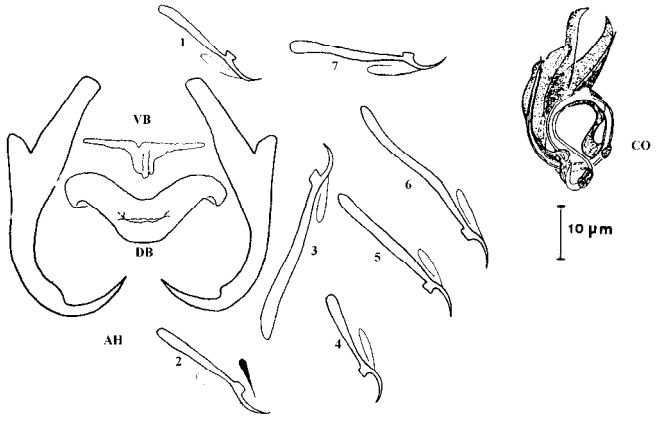
157 (153). The length of the distal part of the pincer-shaped bifid structure is less than half the total length of the copulatory organ (about 0.010 mm). The length of the copulatory tube along the curve is greater than 0.050 mm. The length of the accessory piece is less than 0.027 mm.

D. bocageii Alvarez-Pellitero, Vicente et Gonzales-Lanza, 1981 (Fig. 101)

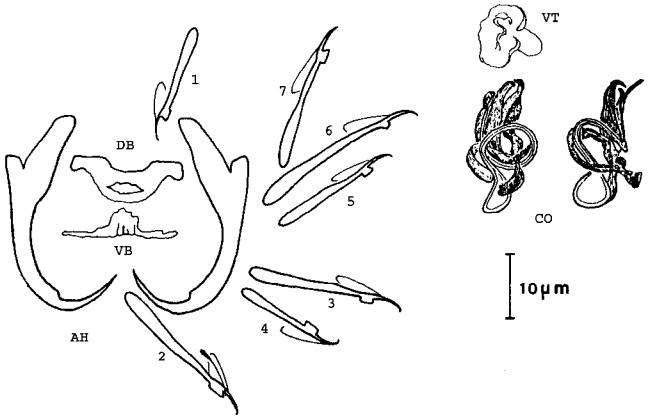
Body length is 0.298 (0.230–0.500) mm and width 0.036 (0.025–0.050) mm. Length of marginal hooks: I: 0.020 (0.017–0.027) mm, II: 0.023 (0.018–0.029) mm, III: 0.033 (0.024–0.040) mm, IV: 0.023 (0.020–0.029) mm, V: 0.030 (0.023–0.037) mm, VI: 0.040 (0.029–0.044) mm, VII: 0.033 (0.025–0.036) mm.



97

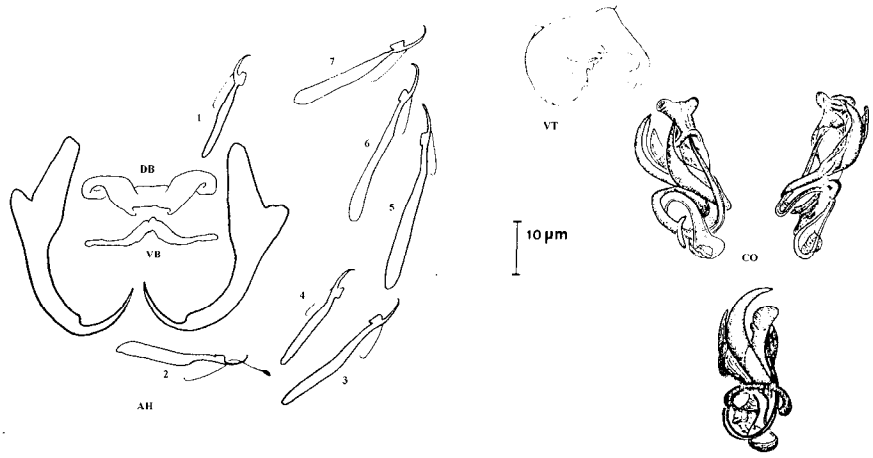


98

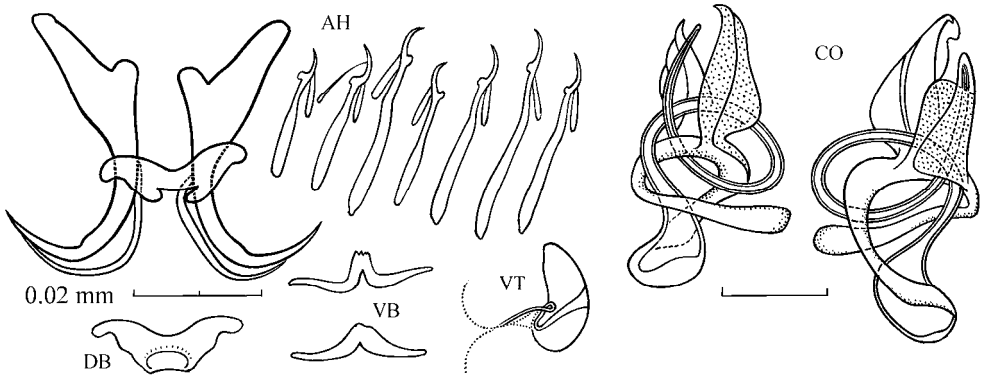


99

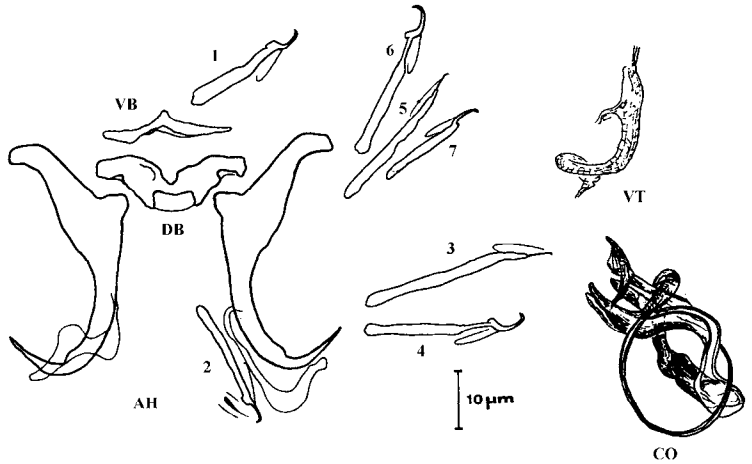
Fig. 97 – 99.
97 - *Dactylogyrus comizae* (after El-Gharbi et al., 1992). **98 -** *Dactylogyrus guadianensis* (after El-Gharbi et al., 1992). **99 -** *Dactylogyrus doadrioi* (after El-Gharbi et al., 1992).



100



101



102

Fig. 100 – 102.
100 - *Dactylogyrus lenkoranoides* (after El-Gharbi et al., 1992). **101**- *Dactylogyrus bocageii* from *Luciobarbus bocagei*. **102** - *Dactylogyrus zatensis* (after El-Gharbi et al., 1994).

Length of anchors is 0.042 (0.033–0.043) mm, main part 0.0315 (0.025–0.033) mm, outer root 0.004 (0.003–0.004) mm, inner root 0.0155 (0.013–0.018) mm, point 0.013 (0.010–0.014) mm. Size of dorsal bar is 0.006 (0.003-0.007) x 0.028 (0.024-0.030) mm, ventral bar 0.003 (0.003-0.005) x 0.026 (0.016-0.029) mm. Length of copulatory organ is 0.032 (0.030–0.035) mm, tube 0.070 (0.065–0.074) mm, accessory piece 0.025 (0.021–0.027) mm.

Found on gills of ***Barbus haasi, Luciobarbus graellsii, L. guiraonis, L. bocagei,*** and ***L. sclateri***; Spain.

158 (166). These worms belong to the "varicorhini" group. They are parasites of fish inhabiting water bodies of Northwest Africa (Morocco, Tunisia).

159 (163). The copulatory tube is thin (0.001 mm in diameter).

160 (161). The anchor inner root has a bent end. The vaginal armament is in the form of the bent tube.

D. zatensis El Gharbi, Birgi et Lambert, 1994 (Fig. 102)

Body length is 0.433 (0.314–0.579) mm, width 0.057 (0.037–0.087) mm. Length of marginal hooks: I: 0.023 (0.021–0.025) mm, II: 0.023 (0.019–0.028) mm, III: 0.026 (0.023–0.028) mm, IV: 0.022 (0.020–0.025)mm, V: 0.026 (0.024–0.030) mm, VI: 0.028 (0.025–0.034) mm, VII: 0.023 (0.020–0.025) mm. Total length of anchors is 0.043 (0.040–0.047) mm, main part 0.032 (0.029–0.039) mm, outer root 0.004 (0.003–0.007)mm, inner root 0.021 (0.016–0.029) mm, point 0.013 (0.011–0.016) mm. Size of dorsal bar is 0.006 (0.004-0.008) x 0.027 (0.021-0.033) mm, ventral bar 0.004 (0.002-0.005) x 0.020 (0.016-0.021) mm. Length of copulatory organ is 0.037 (0.031–0.042)mm. Length of vaginal armament is 0.041 (0.036–0.044) mm.

Found on gills of ***Labeobarbus fritschii***; Morocco.

161 (162). The anchor inner root does not have a bent end. The vaginal armament is Ω shaped.

D. reinii El Gharbi, Birgi et Lambert, 1994 (Fig. 103)

Body length is 0.431 (0.298–0.630) mm, width 0.081 (0.071–0.129) mm. Length of marginal hooks: I: 0.024 (0.020–0.029) mm, II: 0.025 (0.023–0.028) mm, III: 0.037 (0.026–0.042) mm, IV: 0.025 (0.021–0.028) mm, V: 0.031 (0.027–0.034) mm, VI: 0.036 (0.035–0.038) mm, VII: 0.027 (0.024–0.033) mm. Length of anchors is 0.048 (0.047–0.052) mm, main part 0.034 (0.027–0.036) mm, outer root 0.006 (0.004–0.006) mm, inner root 0.019 (0.015–0.024) mm, point 0.014 (0.013–0.015) mm. Size of dorsal bar is 0.007 (0.006-0.008) x 0.024 (0.027-0.032) mm, ventral bar 0.005 (0.003-0.006) x 0.021 (0.017-0.026) mm. Length of copulatory organ is 0.031 (0.028–0.036) mm.

Found on gills of ***Labeobarbus reinii***; Morocco.

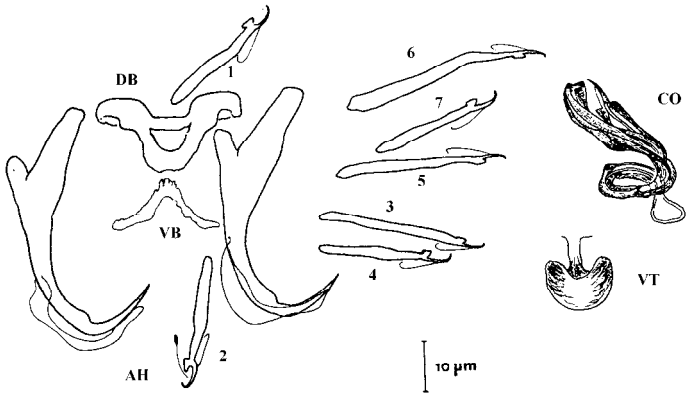
162 (161). The anchor inner root does not have a bent end. The vaginal armament is in the form of the bent tube with an expanded end.

D. oumiensis El Gharbi, Birgi et Lambert, 1994 (Fig. 104)

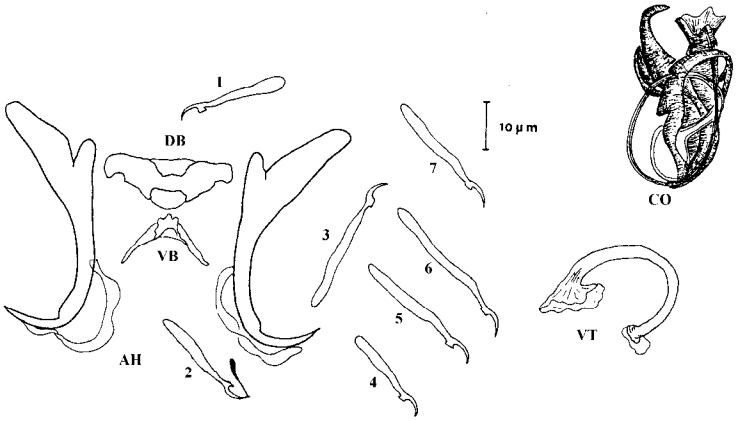
Body length is 0.542 (0.344–0.857) mm, width 0.084 (0.056–0.130) mm. Length of marginal hooks: I and II pairs: 0.024 (0.018–0.030) mm, III: 0.032 (0.025–0.037) mm, IV: 0.027 (0.020–0.034) mm, V: 0.031 (0.024–0.040) mm, VI: 0.034 (0.026–0.042) mm, VII: 0.030 (0.024–0.034) mm. Length of anchors is 0.044 (0.033–0.055) mm, main part 0.033 (0.030–0.036) mm, outer root 0.005 (0.003–0.008) mm, inner root 0.016 (0.012–0.019) mm, point 0.013 (0.011–0.015) mm. Size of dorsal bar is 0.006 (0.004-0.008) x 0.026 (0.018-0.031) mm, ventral bar 0.005 (0.003-0.007) x 0.020 (0.015-0.026) mm. Length of copulatory organ is 0.040 (0.034–0.054), length of vaginal tube 0.045 (0.030–0.060) mm.

Found on gills of ***Barbus harterti, B. paytonii***, and ***Labeobarbus reinii***; Morocco.

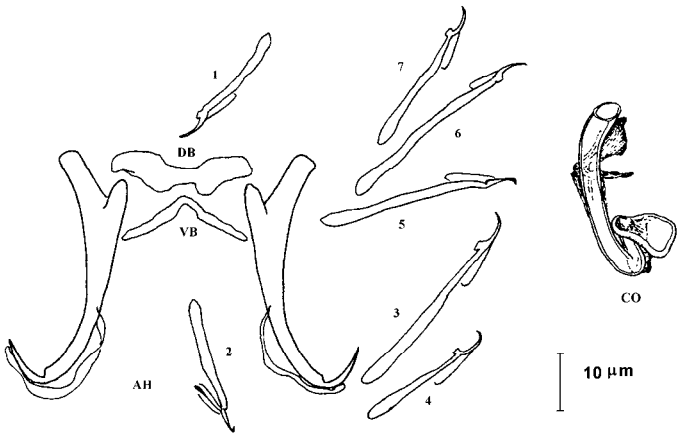
163 (159). Copulatory tube is wide 0.003 mm in diameter.



103



104



105

Fig. 103 – 105.
103 - *Dactylogyrus reinii* (after El-Gharbi et al., 1994). **104** *Dactylogyrus oumiensis* (after El-Gharbi et al., 1994). **105** - *Dactylogyrus kulindrii* (after El-Gharbi et al., 1994).

164 (165). The length of the dorsal bar is less than 0.027 mm. The copulatory tube has a broadened end. The accessory piece is not well developed.

D. kulindrii El Gharbi, Birgi et Lambert, 1994 (Fig. 105)

Body length is 0.334 (0.224–0.427) mm, width 0.054 (0.041–0.071) mm. Length of marginal hooks: I: 0.021 (0.018–0.025) mm, II: 0.020 (0.017–0.023) mm, III: 0.029 (0.023–0.035) mm, IV: 0.024 (0.022–0.028) mm, V: 0.031 (0.023–0.038) mm, VI: 0.033 (0.026–0.038) mm, VII: 0.028 (0.023–0.035) mm. Total length of anchors is 0.043 (0.037–0.047) mm, main part 0.033 (0.025–0.037) mm, outer root 0.005 (0.003–0.007) mm, inner root 0.014 (0.011–0.016) mm, point 0.011 (0.009–0.016) mm. Size of dorsal bar is 0.006 (0.004-0.008) x 0.023 (0.021-0.027) mm, ventral bar 0.003 (0.002-0.005) x 0.020 (0.017-0.024) mm. Length of copulatory organ is 0.028 (0.022–0.035) mm.

Found on gills of *Labeobarbus fritschii* and *L. reinii*; Morocco.

165 (164). The length of the dorsal bar is greater than 0.027 mm. The copulatory tube has a narrowed end. The accessory piece is well developed with two projections at the end.

D. volutus El Gharbi, Birgi et Lambert, 1994 (Fig. 106)

Body length is 0.351 (0.278–0.432) mm, width 0.074 (0.046–0.098) mm. Length of marginal hooks: I: 0.025 (0.020–0.031) mm, II: 0.029 (0.022–0.037) mm, III: 0.034 (0.027–0.038) mm, IV: 0.031 (0.026–0.038) mm, V: 0.036 (0.027–0.042) mm, VI: 0.037 (0.032–0.043) mm, VII: 0.032 (0.028–0.036) mm. Total length of anchors is 0.043 (0.038–0.051) mm, main part 0.034 (0.029–0.039) mm, outer root 0.006 (0.004–0.008) mm, inner root 0.013 (0.011–0.018) mm, point 0.011 (0.009–0.016) mm. Size of dorsal bar is 0.006 (0.003-0.007) x 0.024 (0.027-0.031) mm, ventral bar 0.005 (0.003-0.007) x 0.025 (0.019-0.030) mm. Length of copulatory organ is 0.034 (0.026–0.042) mm, accessory piece 0.025 (0.020–0.030) mm.

Found on gills of *Labeobarbus fritschii*; Morocco.

166 (158). These worms belong to the “varicorhini” group. They are parasites of fish inhabiting water bodies of Iran.

167 (168). The total length of the anchors is less than 0.025 mm. The short accessory piece enlarges into pallium.

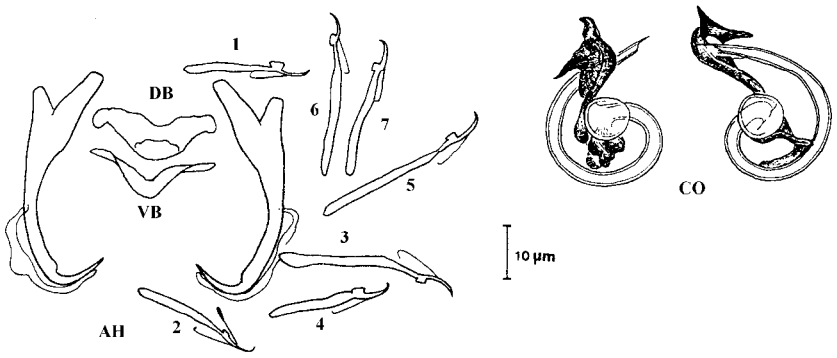
D. pallicirrus Jalali, Papp et Molnar, 1995 (Fig. 107)

Body length is 0.396 (0.363–0.429) mm, width 0.048 (0.046–0.053) mm. Total length of marginal hooks is 0.021 (0.018–0.024). Length of anchors: dorso-apical 0.022 (0.021–0.024) mm, ventro-apical 0.019 (0.018–0.019) mm, main part 0.019 (0.017–0.019) mm, outer root 0.001 (0.001–0.002) mm, inner root 0.010 (0.009–0.010) mm, point 0.008 (0.008–0.009) mm. Size of dorsal bar is 0.002 x 0.015 (0.013-0.017) mm, ventral bar 0.003 (0.002-0.004) x 0.012 (0.011-0.013) mm. Total length of copulatory organ is 0.025 (0.0195–0.030) mm. Vaginal armament is 0.009 (0.008–0.011) mm long.

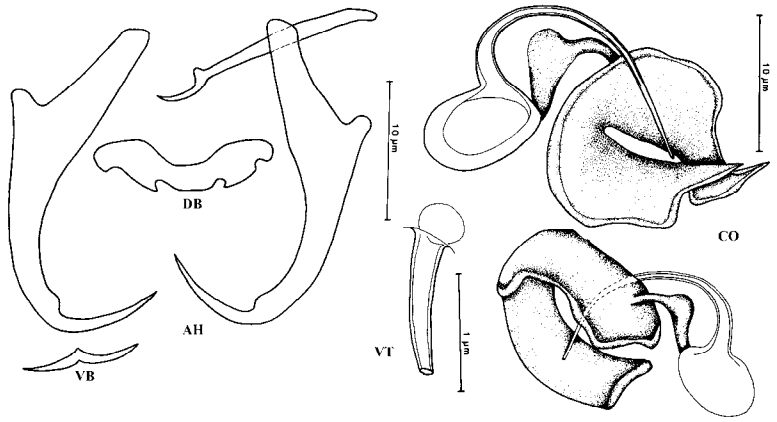
Parasite of *Cyprinion macrostomum* and *C. watsoni*; Dez River, close to city Ahwaz, Tigris Basin, Iran.

168 (167). The total anchor length is greater than 0.025 mm.

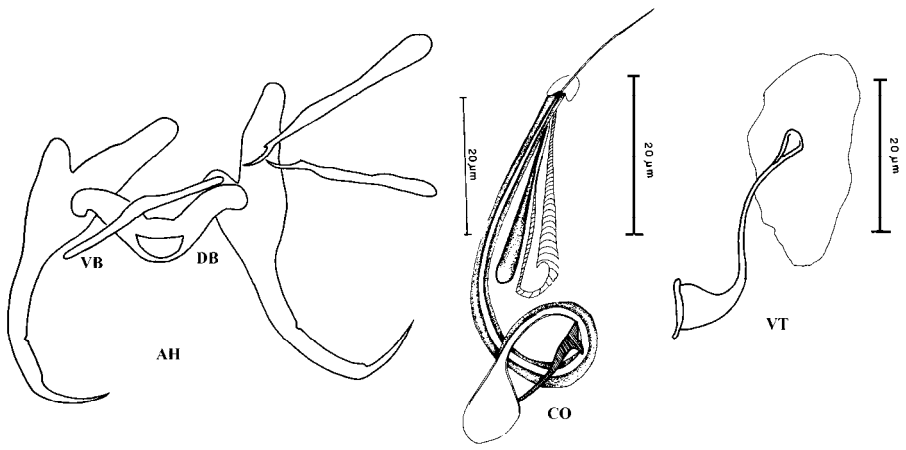
169 (172). Vaginal armament is present.



106



107



108

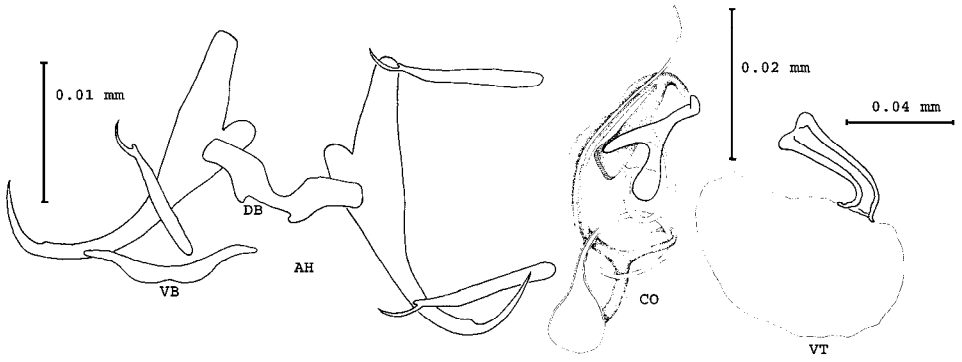
Fig. 106 – 108.
106 - *Dactylogyrus volutus* (after El-Gharbi et al., 1994). **107 -** *Dactylogyrus pallicirrus* (after Jalali et al., 1995). **108 -** *Dactylogyrus rohdeianus* (after Jalali et al., 1995).

170 (171). The length of the vaginal armament is greater than 0.020 mm.

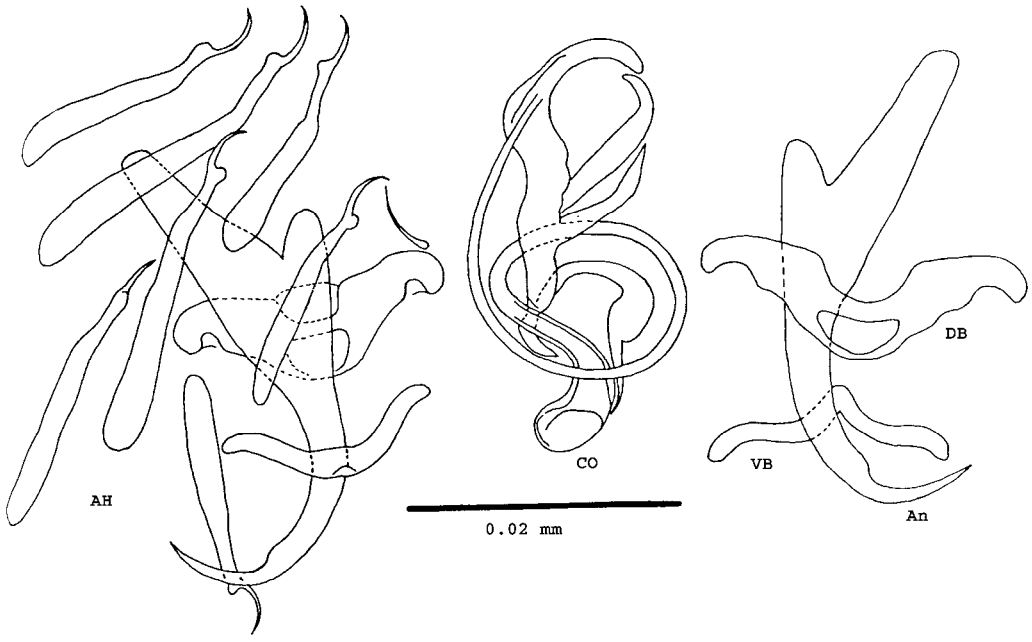
D. rohdeianus Jalali, Papp et Molnar, 1995 (Fig. 108)

Body length is 0.660 (0.627–0.693) mm, width 0.100 (0.086–0.113) mm. Total length of marginal hooks is 0.026–0.043 mm. Length of anchors: dorso-apical 0.044 (0.040–0.047) mm, ventro-apical 0.043 (0.041–0.045) mm, main part 0.038 (0.036–0.039) mm, outer root 0.006 (0.005–0.008) mm, inner root 0.019 (0.018–0.021) mm, point 0.011 (0.010–0.013) mm. Size of dorsal bar is 0.004 x 0.028 (0.027-0.029) mm, ventral bar 0.006 (0.005-0.006) x 0.026 (0.026-0.027) mm. Total length of copulatory organ is 0.060 (0.055–0.064) mm. Vaginal armament is 0.028 (0.026–0.030) mm long.

Parasite of *Capoeta damascina*; Chaghalnandi River, a tributary of the Karkheh River, north of the city of Ahwas, Tigris Basin, Iran.

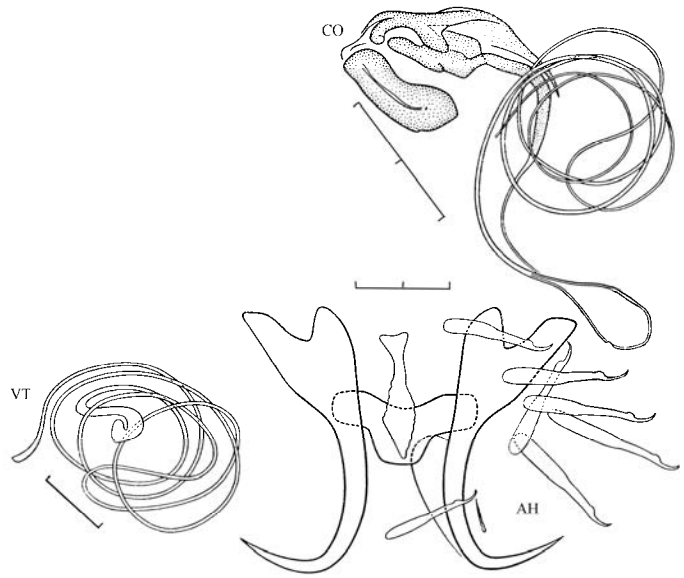


109

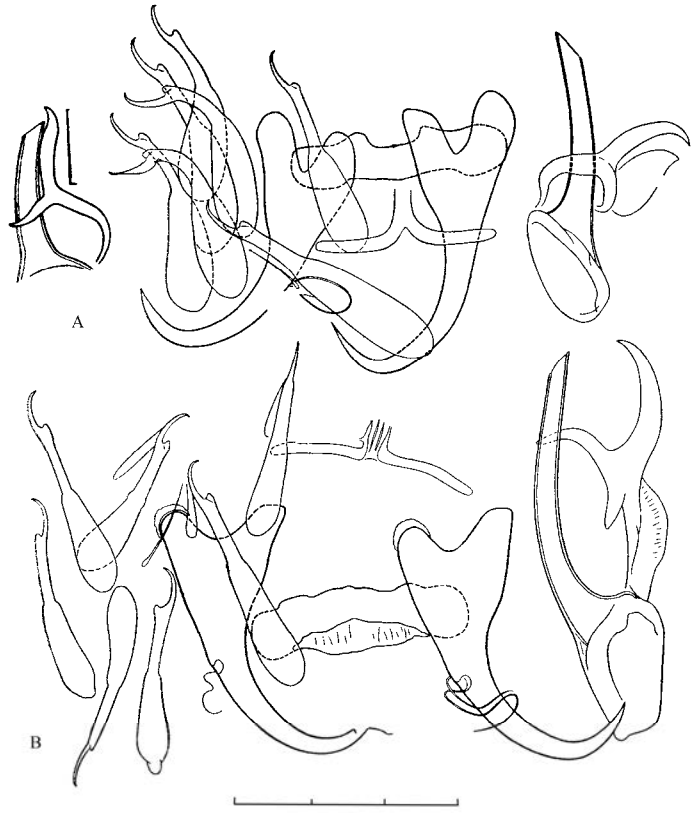


110

Fig. 109 – 110.
109- *Dactylogyrus capoetae* (after Jalali et al., 1995). **110 -** *Dactylogyrus carassobarbi* (after Gussev et al., 1993b).



111



112

Fig. 111 – 112.
111 - *Dactylogyrus simplicimalleata*. **112 -** *Dactylogyrus borealis*: A – from *Phoxinus percnurus*, Lake Onega, B – from *Phoxinus percnurus*, Pechora River (Russia).

171 (170). The length of the vaginal armament is less than 0.020 mm.
D. capoetae Jalali, Papp et Molnar, 1995 (Fig. 109)

Body length is 0.660 (0.561–0.693) mm, width 0.102 (0.095–0.107) mm. Total length of marginal hooks ranges from 0.026 to 0.042 mm. Length of anchors: dorso-apical 0.043 (0.041–0.045) mm, ventro-apical 0.041 (0.040–0.044) mm, main part 0.038 (0.035–0.040) mm, inner root 0.018 (0.017–0.019) mm, outer root 0.005 (0.004–0.008) mm, point 0.013 (0.011–0.013) mm. Size of dorsal bar is 0.005 (0.002-0.005) x 0.031 (0.028-0.032) mm, ventral bar 0.006 (0.004-0.006) x 0.028 (0.024-0.031) mm. Total length of copulatory organ is 0.048 (0.045–0.052). Vaginal armament is 0.018 (0.017–0.019) mm long.

Parasite of *Capoeta damascina*; Chaghalnandi River, a tributary of the Karkheh River, north to city Ahwas, Tigris Basin, Iran.

172 (169). The vaginal armament is absent.
D. carassobarbi Gussev, Jalali et Molnar, 1993 (Fig. 110)

Body length is 0.6–1.35 mm, width 0.081–0.2 mm. Total length of marginal hooks is 0.028–0.032 (I^{th} pair), 0.048 (IV^{th} pair) mm. Length of anchors is 0.048–0.056 mm, main part 0.040–0.042 mm, inner root 0.018–0.022 mm, outer root 0.004–0.008 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.007–0.010 x 0.031–0.038 mm, ventral bar 0.002–0.003 x 0.023–0.030 mm. Total length of copulatory organ is 0.032–0.036 mm, diameter of initial part of tube 0.007 mm, in the middle 0.003 mm, and at the end 0.001 mm. Total length of coiled tube can be up to 0.080 mm.

Parasite of *Carasobarbus luteus*; Dez River, water system of the Tigris River, Iran.

173 (111). The ventral bar lies longitudinally in the haptor and is broadened at the anterior end and in its posterior part, which is pointed; the ventral bar has a curious **T** shape. This is a parasite of *Pelecus cultratus*.
D. simplicimalleata Bychowsky, 1931 (Fig. 111)

These are small or medium size worms; body can be up to 0.6 mm long and 0.10 mm wide. Length of marginal hooks is 0.020–0.036 mm. Length of anchors is 0.056–0.066 mm, main part 0.049–0.056 mm, inner root 0.012–0.017 mm, outer root 0.007–0.010 mm, point 0.017–0.020 mm. Size of dorsal bar is 0.018–0.022 x 0.029–0.035 mm, ventral bar 0.025– 0.032 x 0.006–0.008 mm. Total length of copulatory organ is 0.060–0.100 mm, length of tube along the curve up to 0.340 (diameter less than 0.0005) mm. Size of vaginal "ball" is about 0.030 mm, length of tube about 0.300 mm.

Found on gill filaments of *Pelecus cultratus*; distribution coincides with the host area.

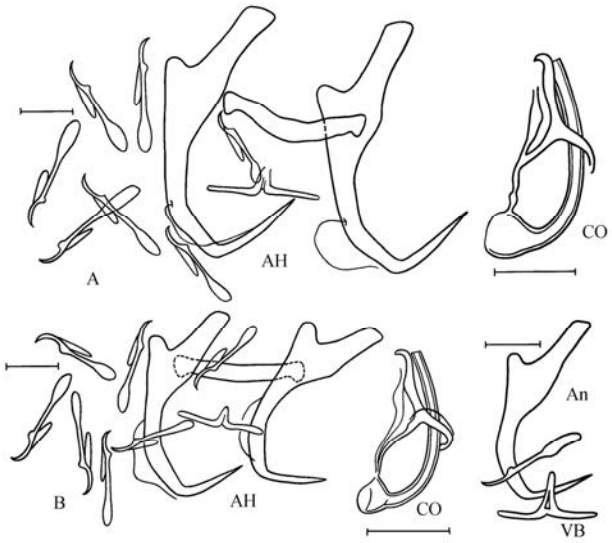
174 (110). The ventral bar has projections.

175 (249). The ventral bar is ⊥ shaped, sometimes with a fringe-like posterior projection or with a groove at the posterior edge.

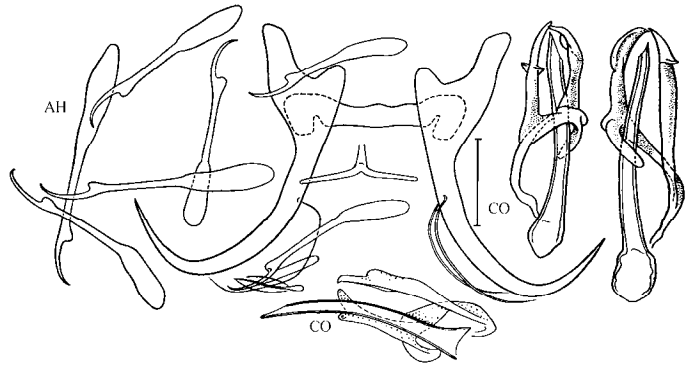
176 (185). The anterior projection of the ventral bar is small, in most cases pointed at its end and shorter than the lateral wings of the bar; a shallow groove often can be seen in the middle of its posterior side.

177 (184). The vaginal armament is absent; the copulatory organ is of the “anchoratus- borealis” type, with a simple tube and a trefoil-shaped accessory piece.

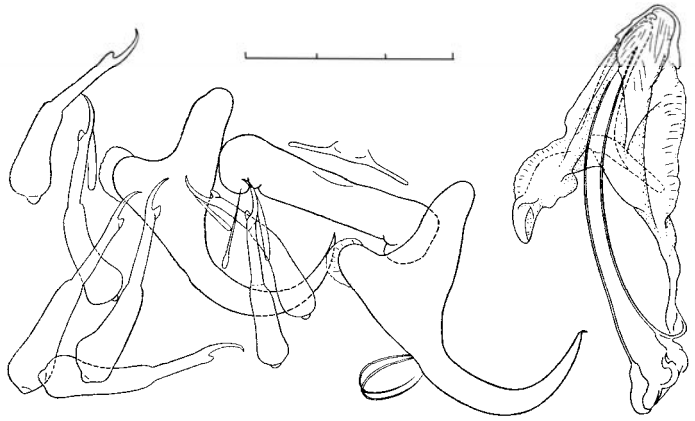
178 (179). The inner and outer roots of the anchors are equal in size; the first is sometimes slightly larger than the second; the dorsal bar has broadened rounded ends.
D. borealis Nybelin, 1936 (Fig. 112)



113



114



115

Fig. 113 – 115.
113- *Dactylogyrus phoxini*: A – "large" form from Lake Khanka, B – "little" form from the same lake (after Gussev, 1955a). **114 -** *Dactylogyrus ersinensis.* **115 -** *Dactylogyrus oreoleucisci*.

These are small or medium size worms; body can be up to 0.8 mm long and 0.2 mm wide. Length of the marginal hooks is 0.026–0.044 (the second is the largest pair) mm. Length of anchors: dorso-apical 0.034–0.038 mm, ventro-apical 0.037–0.046 mm, main part 0.030–0.034 mm, inner root 0.007–0.011 mm, outer root 0.006–0.012 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.004–0.008 x 0.025–0.035 mm, ventral bar 0.004–0.010 x 0.024–0.029 mm (with an anterior projection of various shape and length). The copulatory organ tube is highly variable in length and width; its length ranges from 0.039 to 0.055 mm. Lambert (1977a) noted that a vaginal "plate" is present.

Found on gill filaments of minnows *Phoxinus phoxinus*, *P. lagowskii*, *P. brachyurus*, and *Squalius cephalus* (?); distribution coincides with the host area.

179 (178). The outer root is narrower than and twice as short as the inner root; the dorsal bar has broadened ends that are prolonged backwards.

180 (183). The anchors are thin. The "petals" of the accessory piece of the copulatory organ are thin.

181 (182). The length of the anchors usually is greater than 0.040 mm; the tube of the copulatory organ is **C** shaped.

D. phoxini Malewitzkaja, 1949 (Fig. 113)

These are small worms; body length can be up to 0.5 mm and 0.10 mm wide. Length of marginal hooks is 0.015–0.030 mm. Length of anchors is 0.035–0.047 mm, main part 0.031–0.037 mm, inner root 0.015–0.018 mm, outer root 0.003–0.004 mm, point 0.015–0.018 mm. Size of dorsal bar is 0.004 x 0.022–0.028 mm, ventral bar 0.003–0.009 x 0.015–0.020 mm. Total length of copulatory organ is 0.021–0.031 mm, diameter of tube in its middle is less than 0.0025 mm.

Found on gill filaments of *Phoxinus phoxinus*, *P. percnurus*, *P. p. mantschuricus*, *Oreoleuciscus humilis*, and *O. potanini*; water bodies of the Palaearctic and Amur regions.

Gussev (1955a) described "little" and "large" types of this species. Measurements of the chitinoid structures of the “little” type are close to the minimum and of the “large” type are close to the maximum. Ergens and Dulmaa (1970) described a third type of *D. phoxini* from the gills of all species of the genus *Oreoleuciscus* found in rivers and lakes of western Mongolia. It has a larger copulatory organ (0.035–0.044 mm) and is similar to *D. malewitzkajae* Gussev, 1955 and *D. gvosdevi* Gussev, 1955. Based on the specimens from the same hosts and localities, Pugachev (1988) established the subspecies *D. phoxini mongolicus* for this form.

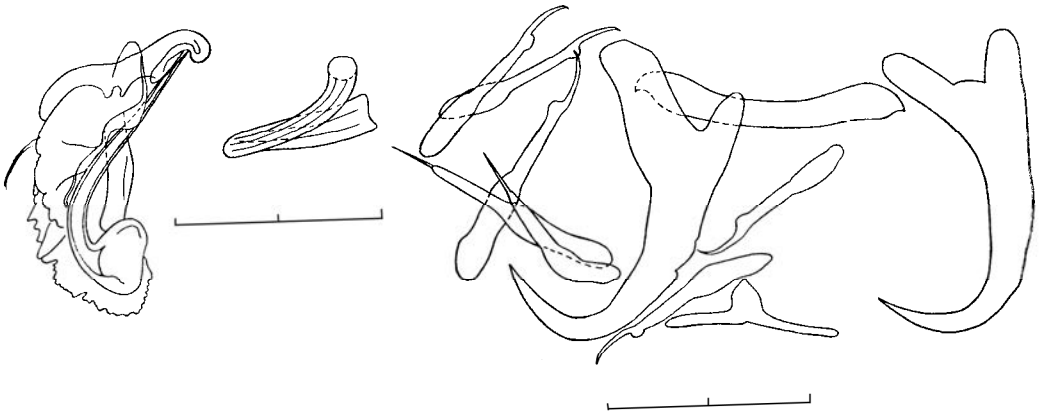
182 (181). The length of the anchors usually is less than 0.030 mm. The tube of the copulatory organ is nearly straight; the accessory piece is **H** shaped.

D. ersinensis Spassky et Roytman, 1960 (Fig. 114)

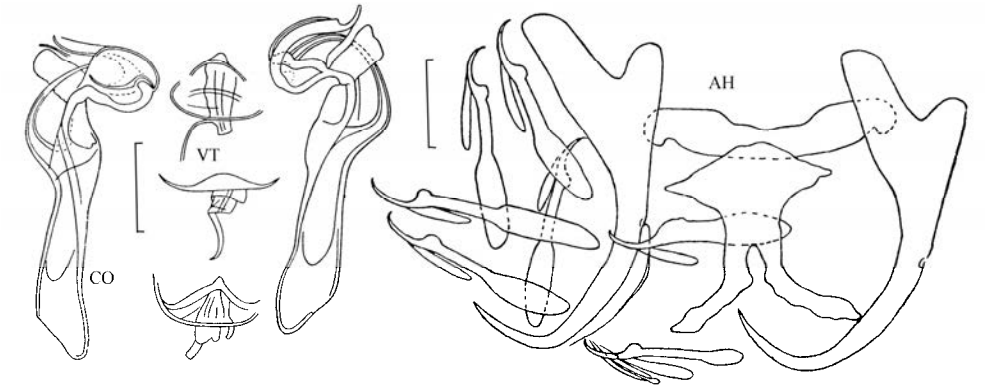
These are small or medium size worms; body can be up to 0.58 mm long and 0.16 mm wide. Length of marginal hooks is 0.018–0.028 mm. Length of anchors is 0.029–0.034 mm, main part 0.025–0.028 mm, inner root 0.005–0.008 mm, outer root 0.003–0.004 mm, point 0.008–0.010 mm. Size of dorsal bar is 0.0025–0.0030 x 0.018–0.023 mm, ventral bar 0.003–0.004 x 0.014–0.016 mm. Total length of copulatory organ is 0.028–0.037 (in Ergens and Dulmaa, 1967: 0.025–0.027) mm.

Found on gill filaments of *Oreoleuciscus humilis*; Tes-khem River and Lake Ubsunur (Tuva, Russia); all *Oreoleuciscus* species from lakes and rivers of western Mongolia. Ergens and Dulmaa (1967, 1970) found it on gills of *Phoxinus* sp., Selbe River near Ulan–Bator (Mongolia), and Pugachev (2002) found it on gills of *P. percnurus* from the Anadyr’ River (Chukotka, Russia).

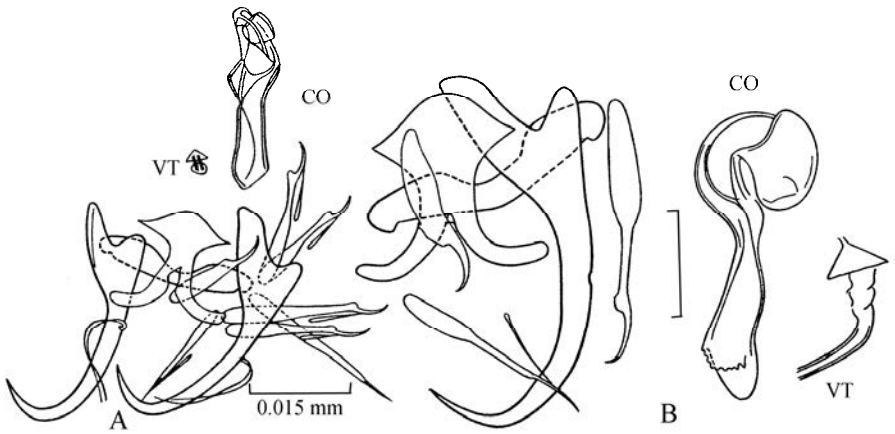
183 (180). The anchors are massive and broad. The "petals" of the accessory piece of the copulatory organ are in the form of a massive triangular shield.



116



117



118

Fig. 116 – 118.
116 - *Dactylogyrus volgensis* (after Gussev, 1966b). **117 -** *Dactylogyrus minor* from *Alburnus alburnus* (Lake Vrevo, Leningrad region, Russia). **118 -** *Dactylogyrus minor*: A - *D. "pseudominor"* (after Osmanov, 1965), B – from *Alburnoides bipunctatus eichwaldi*, Uzbekistan.

D. oreoleucisci Ergens et Dulmaa, 1970 (Fig. 115)

These might be small worms, but total length was not given in the first description. Length of marginal hooks is 0.023–0.034 mm. Length of anchors is 0.033–0.035 mm, main part 0.027–0.028 mm, inner root 0.013–0.016 mm, outer root 0.004–0.005 mm, point 0.012–0.013 mm. Size of dorsal bar is 0.006–0.007 x 0.033–0.038 mm, ventral bar 0.002–0.003 x 0.019 mm (in first description not mentioned). Length of copulatory organ is 0.052–0.063 mm, diameter of tube in its middle 0.003 mm.

Found on gill filaments of *Oreoleuciscus humilis* and *O. potanini*; rivers and lakes of western Mongolia. Pugachev (2002) found it on gills of *Phoxinus percnurus*, Lena River (Siberia, Russia).

184 (177). The vaginal armament is in the form of a short, broad, and bent tube. The accessory piece of the copulatory tube is tubercular that goes around the tube, which bends at its initial part.

D. volgensis Gussev, 1966 (Fig. 116)

These are small worms; body can be up to 0.4 mm long and 0.10 mm wide. Length of marginal hooks is 0.017–0.026 mm. Length of anchors is 0.030–0.031 mm, main part 0.025– 0.027 mm, inner root 0.012–0.013 mm, outer root 0.05 mm, point 0.010 mm. Size of dorsal bar is 0.003 x 0.027 mm, ventral bar 0.005 x 0.016–0.018 mm. Length of copulatory organ is 0.030 mm. The vaginal tube is bent: length 0.032 mm, diameter 0.002–0.003 mm.

Found on gill filaments of *Blicca bjoerkna*; Volga River Delta.

185 (176). The anterior projection of the ventral bar is long (nearly the length of the lateral transverse wing of the bar and sometimes longer); more often the posterior edge of the bar's lateral transverse wing has a hollow, sometimes with a short fimbriated projection in the middle.

186 (189). The first pair of marginal hooks is massive and differ from the others by having a large blade; the ventral bar has a very massive anterior projection that noticeably dilates to its end.

187 (188). The end part of the anterior projection of the ventral bar is diamond shaped. The expanded initial part of the copulatory organ tube is very long (longer than the narrow sickle-shaped distal end). The fungiform vaginal armament is short. These are parasites of genera *Alburnus* and *Alburnoides*.

D. minor Wagener, 1857 (Fig. 117, 118)

Syn.: *D. pseudominor* Osmanov, 1965

These are small worms; body length can be up to 0.42 mm and width to 0.07 mm. Length of marginal hooks is 0.016–0.026 mm. Length of anchors is 0.031–0.037 mm, main part 0.027–0.032 mm, inner root 0.009–0.011 mm, outer root 0.004–0.005 mm, point 0.007–0.009 mm. Size of dorsal bar is 0.004–0.005 x 0.021–0.027 mm, ventral bar 0.014–0.016 x 0.018–0.021 mm. Length of copulatory organ is 0.033–0.038 mm. Length of fungiform vaginal armament is about 0.010 mm, diameter of its "cap" about 0.013 mm.

Found on gill filaments of *Alburnus alburnus, A. philippi*, *A. alborella, Alburnoides bipunctatus*, *A. b. eichwaldi*, *A. taeniatus*, and *A. oblongus*; in all water bodies where its hosts live. It is found in many water bodies of Europe (southern France, Czechia, Slovakia, Bulgaria, Russia, etc.), Azerbaidjan, Tajikistan, Kazakhstan, and Uzbekistan.

It seems that *D. pseudominor* described by Osmanov (1965) does not differ from typical *D. minor*. The characteristics of the latter became better known when material was gathered from new regions of Russia. The copulatory organ of *D. pseudominor* seems to be a little shorter (0.026–0.029 mm) than that of *D. minor*. All other indices are within the limits of *D. minor*. Osmanov was right when he identified this form as *D. minor* in his preceding papers.

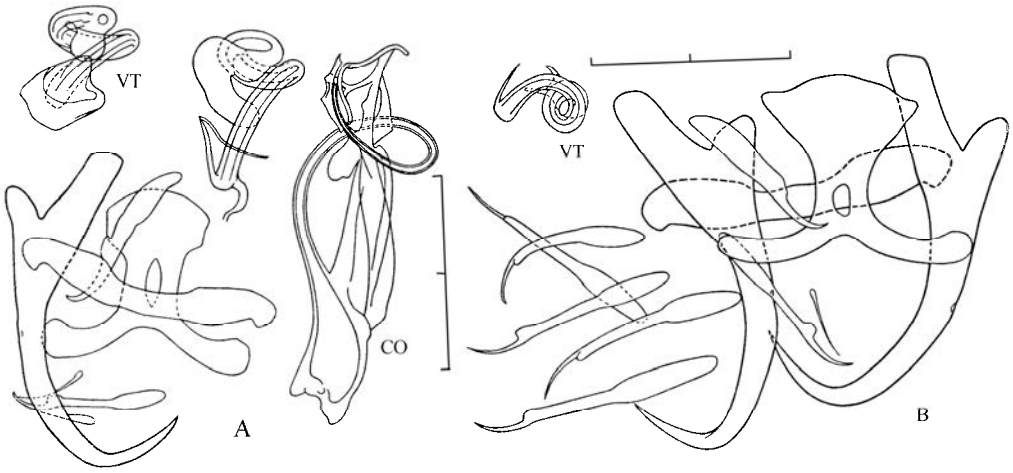
188 (187). The end part of the anterior projection of the ventral bar is triangular, sometimes with truncated angles (ventral bar looks like a rail in section), The initial widened part of the copulatory organ tube is short and the tube is twisted into a spiral. The vaginal armament is like a bent

tube. These are parasites of ***Alburnus chalcoides*** and ***Alburnoides taeniatus*** (?).

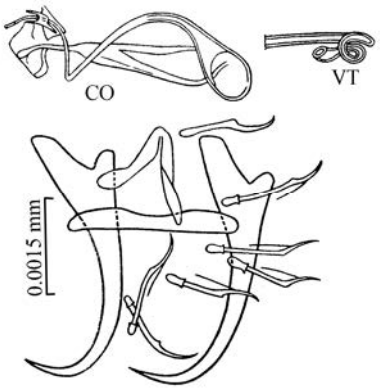
D. chalcalburni Dogiel et Bychowsky, 1934 (Fig. 119)

Syn.: ***D. narimani*** Osmanov, 1965 (?)

These are small or medium size worms; body can be up to 0.68 mm long and 0.17 mm wide. Length of marginal hooks is 0.016–0.026 mm. Length of anchors is 0.032–0.038 mm, main part 0.026–0.030 mm, inner root 0.010–0.012 mm, outer root 0.004–0.005 mm, point about 0.010 (in first description 0.013) mm.



119



120

Fig. 119 – 120.

119 - *Dactylogyrus chalcalburni*: A – from Aral sea, B – from water bodies of Azerbaidjan.

120 - *Dactylogyrus "narimani"* (after Osmanov, 1965).

Size of dorsal bar is 0.003 x 0.025–0.031 mm, ventral bar 0.013–0.017 x 0.021–0.026 mm. Length of copulatory organ is 0.040–0.047 mm, tube about 0.057 mm. Vaginal tube is bent into a loop, with a widening or a discal plate (?) at the posterior end; its length along the curve is 0.025–0.030 mm, diameter 0.002 mm.

Found on gill filaments of *Alburnus chalcoides*, *A. c. aralensis*, *A. c. mento*, and *Alburnoides taeniatus* (?); basin of the Caspian and Aral Seas; Crimea rivers.

Analysis of the description and figure of *D. narimani*, which were made using only one specimen from *Alburnoides taeniatus* (?) from the Zeravshan River (Uzbekistan), and comparative studies of it and *D. chalcalburni* have shown that these two species may be synonymous. The structure and size of the copulatory organ, vaginal armament, bar, and anchors are the same in both species. The differences between them include different hosts and differences in the shape of the ventral bar and marginal hooks. However, the ventral bar of one specimen of *D. narimani* was deformed when the slide was made. The hosts of both species are very similar. Thus, the real difference is in the dimensions of the marginal hooks; handles are undeveloped in *D. narimani*. It is possible that Osmanov (1965) had a young specimen; if so then this feature is not very important (Fig. 120). Nevertheless, this problem remains unsolved.

We give the features of *D. narimani* using the first description (Osmanov, 1965): length of marginal hooks is 0.014–0.017 mm; length of anchors is 0.033 mm, main part 0.027 mm, inner root 0.008 mm, outer root 0.004 mm, point 0.007 mm; size of dorsal bar is 0.002 x 0.024 mm, ventral bar 0.012 x 0.013 mm, copulatory organ 0.035 mm, vaginal tube (total, not along the curve) 0.010 mm. These measurements are lower than one can get from Osmanov's figure according to his scale.

189 (186). All marginal hooks are the same size and shape; their blade also is identical. The anterior projection of the ventral bar sometimes is widened evenly along the whole length or is slightly widened at its end.

190 (193). The anterior projection of the ventral bar is thin and pointed at its end; a posterior projection is present in some specimens, in which case the bar is cross-like.[24] These are parasites of *Capoetobrama kuschakewitschi*.

191 (192). The tube of the copulatory organ is sickle shaped in its proximal part; it is bubble shaped at the beginning and then becomes cylindrical.

D. capoetobramae Kuzmenko, 1945 (Fig. 121)

These are small worms; body length is up to 0.4 mm and width to 0.09 mm. Length of marginal hooks is 0.017–0.030 mm. Length of anchors is 0.032–0.035 mm, main part 0.025– 0.028 mm, inner root 0.008–0.012 mm, outer root 0.002–0.004 mm, point 0.007–0.010 mm. Size of dorsal bar is 0.003–0.005 x 0.023–0.025 mm, ventral bar 0.010 x 0.013–0.019 mm. Length of copulatory organ is 0.031–0.035 mm. Vaginal armament is absent.

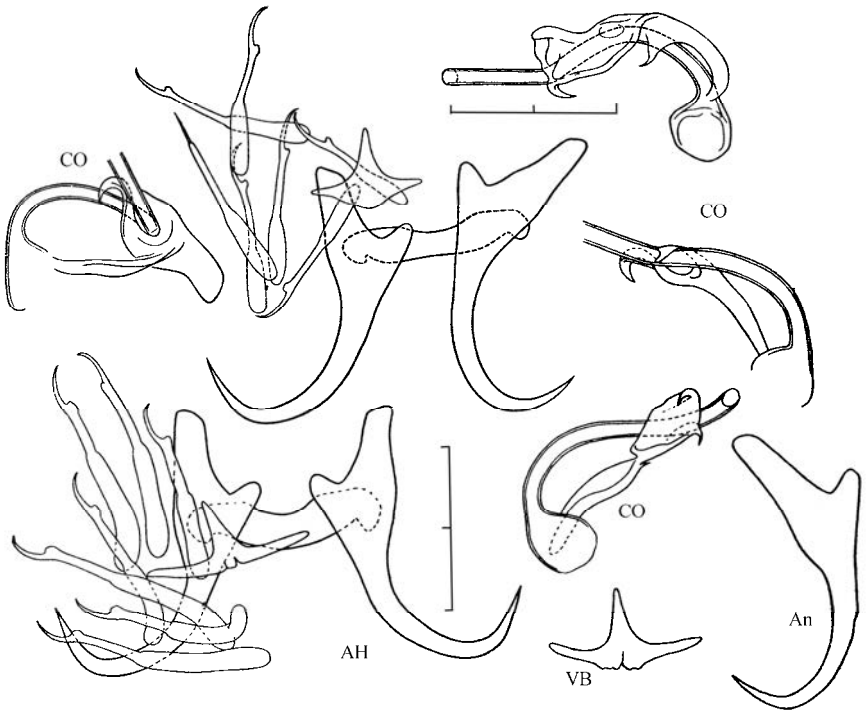
Found on gill filaments of *Capoetobrama kuschakewitschi*; basins of the Amudar'ya and Syrdar'ya Rivers.

192 (191). The tube of the copulatory organ is only slightly bent and gradually tapers to the end; it has a widened and elongated initial part.

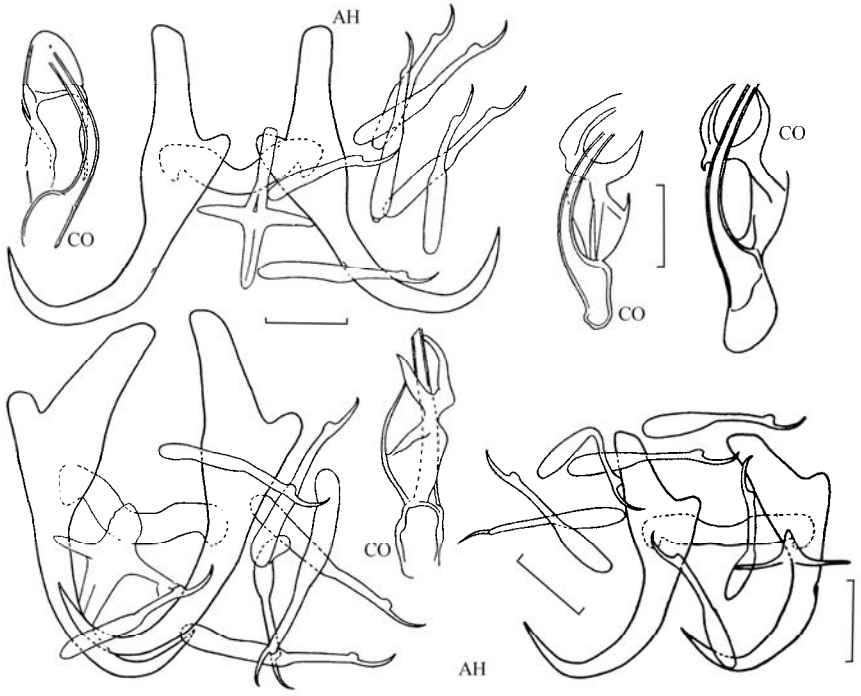
D. turkestanicus Gavrilova, Gussev et Dzhalilov, 1965 (Fig. 122)

Syn.: *D. intestinalis* Allamuratov, 1966; *Dactylogyrus* sp. 2 Osmanov, 1965

[24] See also theses 92, 135, 204, 246, 261.



121



122

Fig. 121 – 122.
121 - *Dactylogyrus capoetobramae*: different specimens from the Kairakkum Reservoir, Tajikistan.
122 - *Dactylogyrus turkestanicus*: different specimens from the Vakhsh River, Tajikistan.

These small worms have a body up to 0.5 mm long and 0.09 mm wide. Length of marginal hooks is 0.018–0.028 mm. Length of anchors is 0.032–0.044 (Allamuratov, 1966: 0.026–0.030) mm, main part 0.026–0.035 (0.018–0.022) mm, inner root 0.010–0.015 mm, outer root 0.002–0.004 mm (in Allamuratov they are confused), point 0.009–0.011 mm. Size of dorsal bar is 0.003–0.005 x 0.020–0.025, ventral bar is ⊥ shaped (or + shaped ?) 0.010–0.020 x 0.015–0.019 mm. Length of copulatory organ is 0.025–0.035 mm. Vaginal armament is absent.

Found on gill filaments and posterior part of intestine of *Capoetobrama kuschakewitschi*; rather rare and only single specimens found; basins of Amudar'ya, Syrdar'ya, and Vakhsh Rivers. Its occurrence in the intestine is of great interest. In freshwaters of the Palaearctic, it is still the only species found in the intestine.

193 (190). The anterior projection of the ventral bar is cylindrical or slightly widened towards rounded end, that sometimes is bifurcated. A small posterior projection is sometimes present at the ventral bar; this projection may consist of lobes or is fringed and broad. This form is transitional to the cross-shaped bar. These are parasites of other fishes.

194 (195). The copulatory organ is of a special "wunderi" type. It has a very long (up to 0.25 mm along the curve) loop-shaped thin tube that is nearly a figure eight. The vaginal tube also is long and forms loops. This is a parasite of *Abramis brama*.

D. wunderi Bychowsky, 1931 (Fig. 123)

These are medium size worms; body length can be up to 0.7 mm and width to 0.15 mm. Length of marginal hooks is 0.020–0.030 mm. Length of anchors is (from fish 3+) 0.043– 0.047 mm, and (from fish 6+ up to 13+) 0.047–0.061 mm, main part 0.032–0.043 mm, inner root 0.016–0.022 mm, point 0.014–0.020 mm. Size of dorsal bar is 0.005–0.007 x 0.028–0.032 mm, ventral bar 0.012–0.016 x 0.020–0.028 mm. Total length of copulatory organ is highly variable and depends on the character of the tube bends (0.080–0.14 mm), length of tube along the curve up to 0.23 mm. Vaginal armament is a twisted tube: its area is 0.020 x 0.035 – 0.035 x 0.065 mm, tube length along the curve 0.20–0.25 mm.

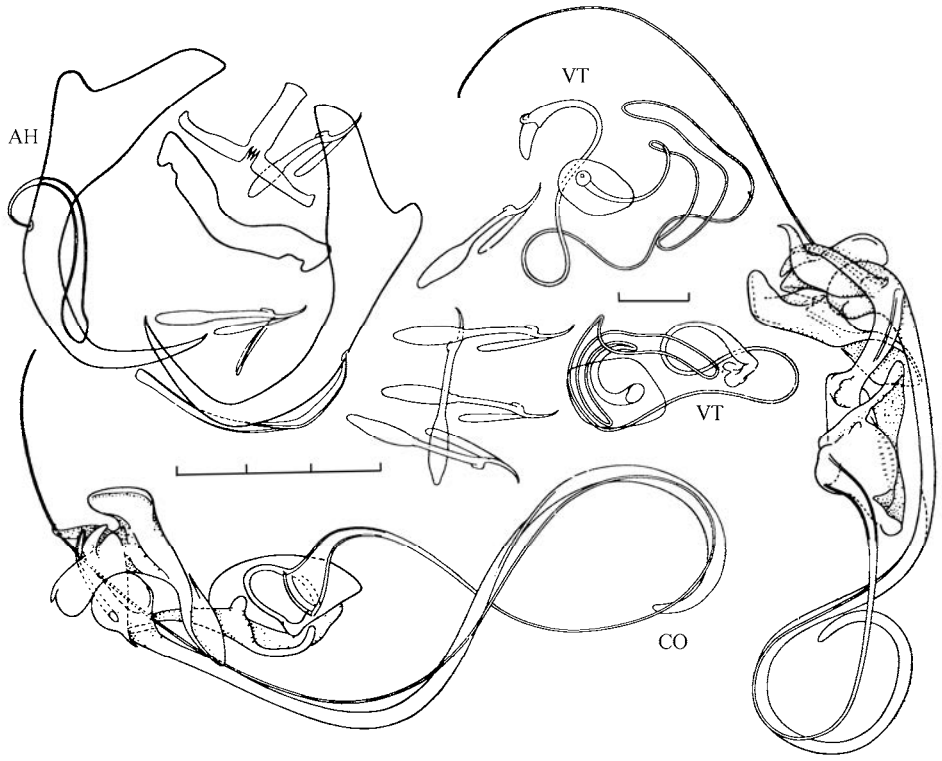
Found on gill filaments of *Abramis brama*; it seems to be present everywhere where bream is present; found in France and Great Britain, where bream was introduced. All data dealing with finds of *D. wunderi* on other fish species seem to be wrong or accidental (see host–parasite list).

195 (194). The copulatory organ is of another type and has a shorter tube (less than 0.14 mm). The vaginal armament also is shorter. These are parasites of *Abramis brama* or other Cyprinids.

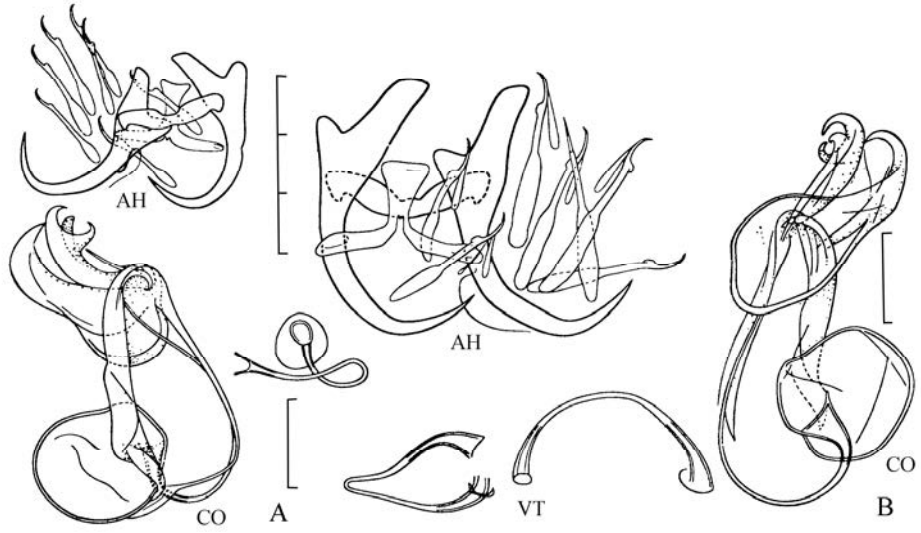
196 (197). The copulatory organ has a bubble-shaped and large (diameter up to 0.020 mm) initial part of the tube, the rest of the tube is sickle -shaped. This is a parasite of *Abramis brama*.

D. zandti Bychowsky, 1933 (Fig. 124)

These are small worms; body can be up to 0.5 mm long and 0.10 mm wide. They are the smallest of the four species specific to bream. Length of marginal hooks is 0.022–0.033 (from fingerlings 0.014–0.020) mm. Length of anchors of specimens from fingerlings or one-summer-old fishes is 0.024–0.032 mm, from fishes 3+ to 6+ 0.031–0.039 mm, from older fishes over 13+ 0.040–0.045 mm, main part 0.030–0.036 (0.020–0.026) mm, inner root 0.011–0.016 (0.007–0.008) mm, outer root 0.003–0.005 (0.002–0.003) mm, point 0.013–0.015 (0.009) mm. Size of dorsal bar is 0.004–0.005 x 0.022–0.030 (0.001–0.003 x 0.015–0.017) mm, ventral bar 0.013–0.016 x 0.027–0.030 (0.008–0.011 x 0.017–0.021) mm. Length of copulatory organ of specimens from fishes of different age is not so variable: from fingerlings and fishes up to 3+ 0.038–0.043 mm, from fishes 6+ to 13+ 0.043–0.051 mm. Length of vaginal tube is 0.032–0.038 (0.027–0.030) mm.



123



124

Fig. 123 – 124.
123 - *Dactylogyrus wunderi*. **124 -** *Dactylogyrus zandti*: A – from bream fry, Lake Seliger (Russia), B – from adult bream, Iriklinskoye water reservoir (River Ural, Russia).

Found on gill filaments of *Abramis brama* (occurrences on other fish species are wrong or accidental, see host–parasite list); its distribution seems to be the same as that of its host; also found in southern France and Great Britain.

197 (196). The copulatory organ usually has a smaller initial part of the tube, in most cases elongated, and it is less than 0.012 x 0.006–0.010 mm.

198 (201). The ventral bar has a narrowing or a swelling of the anterior projection base; the bar's transverse wings are **{** shaped. These are parasites of *Scardinius erythrophthalmus*.

199 (200). The accessory piece of the copulatory organ has an **Є** (or **Э**) -shaped distal end; the copulatory organ tube is **S** (or inverted **S**) –shaped. The vaginal tube is wide, short, and fungiform.
D. difformis Wagener, 1857 (Fig. 125)

These are small worms; body can be up to 0.4 mm long and 0.09 mm wide. Length of marginal hooks is 0.017–0.027 mm. Length of anchors is 0.032–0.043 mm, main part 0.026– 0.035 mm, inner root 0.010–0.014 mm, outer root 0.004 –0.006 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.003–0.005 x 0.024–0.029 mm, ventral bar 0.010–0.013 x 0.019–0.025 mm. Length of copulatory organ is 0.020–0.027 mm, fungiform vaginal armament 0.010–0.012 mm.

Found on gill filaments of *Scardinius erythrophthalmus*. Occurrences on other fish species are wrong (see host–parasite list); its distribution is the same as that of its host; also found in former Yugoslavia (on a subspecies of *S. erythrophthalmus*).

200 (199). The accessory piece of the copulatory organ is shaped like a wide leaf-shaped plate; its distal end undulates; the tube is sickle shaped. The vaginal armament is a narrow long tube with a funnel-shaped end.
D. difformoides Glaeser et Gussev, 1967 (Fig. 126)
Syn.: *D. difformis* Wagener, 1857, part.

These are small worms; body can be up to 0.35 mm long and 0.08 mm wide. Length of marginal hooks is 0.016–0.026 mm. Length of anchors is 0.030–0.036 mm, main part 0.026–0.029 mm, inner root 0.009–0.012 mm, outer root 0.004–0.006 mm, point 0.008–0.010 mm. Size of dorsal bar is 0.004–0.005 x 0.024–0.027 mm, ventral bar 0.008–0.011 x 0.019–0.022 mm. Length of copulatory organ is 0.025–0.032 mm, vaginal tube 0.020–0.032 mm.

Found on gill filaments of *Scardinius erythrophthalmus*; everywhere where its host is found.

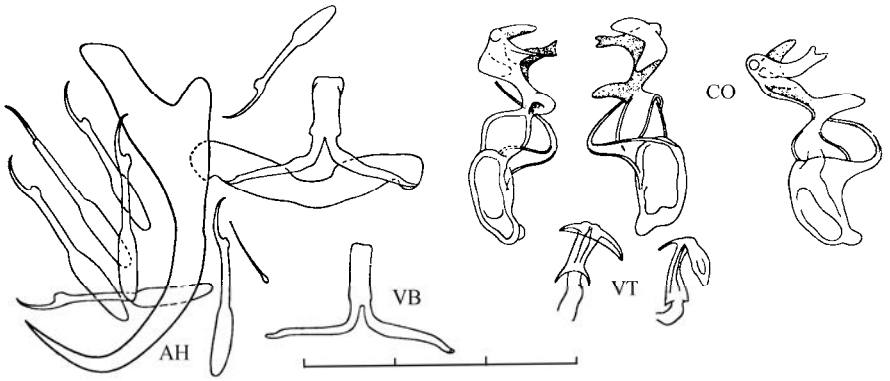
201 (198). The ventral bar is ⊥ shaped and lacks a narrowing or swelling of the anterior projection base; its transverse wings are nearly straight. These are parasites of different fish species.

202 (213). The copulatory organ has a simple accessory piece of the “extensus” or “anchoratus” type; its transverse projection sometimes looks like a swelling near the end of elastic stick-like or flat widening plate.

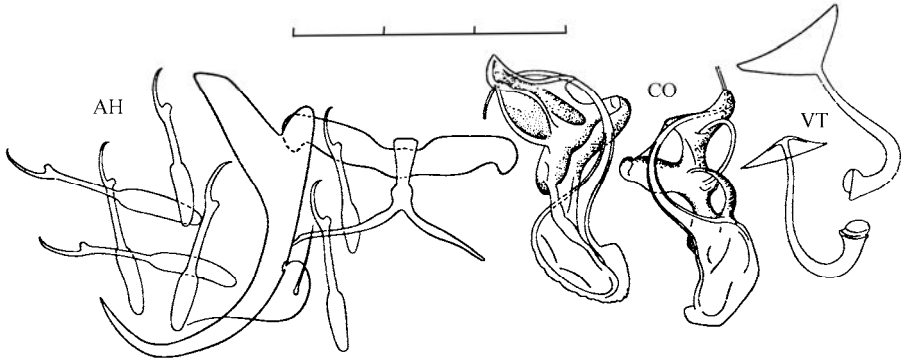
203 (210). The copulatory tube spirally curved and tapers to its end; its broad initial part has a large posterior projection or a small comb or bulges. The vaginal armament may or may not be present.

204 (207). The ventral bar has a short fringed posterior projection that widens at its base and tapers to its end.[25] The elongated initial part of the copulatory tube has a massive short or long posterior projection. Vaginal armament is absent. These are parasites of the genus *Vimba*.

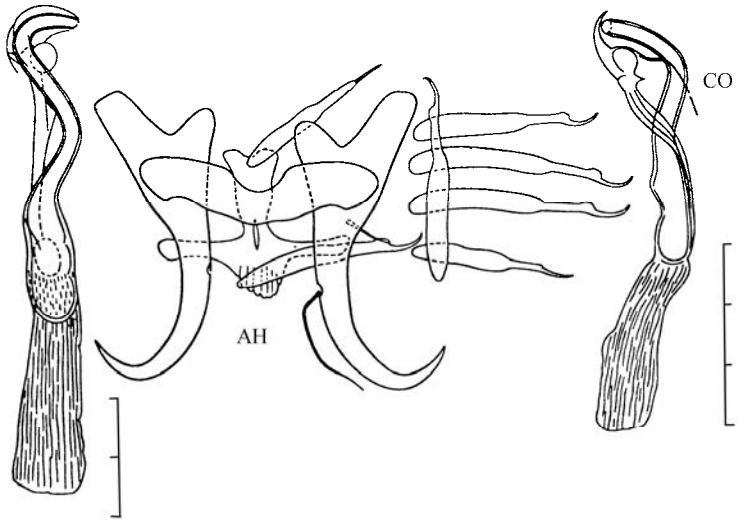
[25] See also theses 92, 135, 190, 246, 250, 261.



125

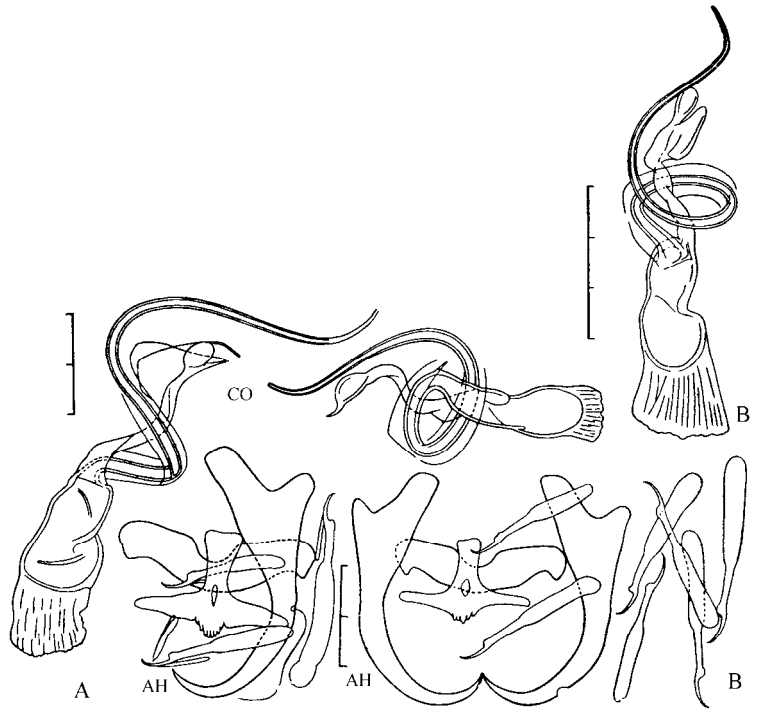


126

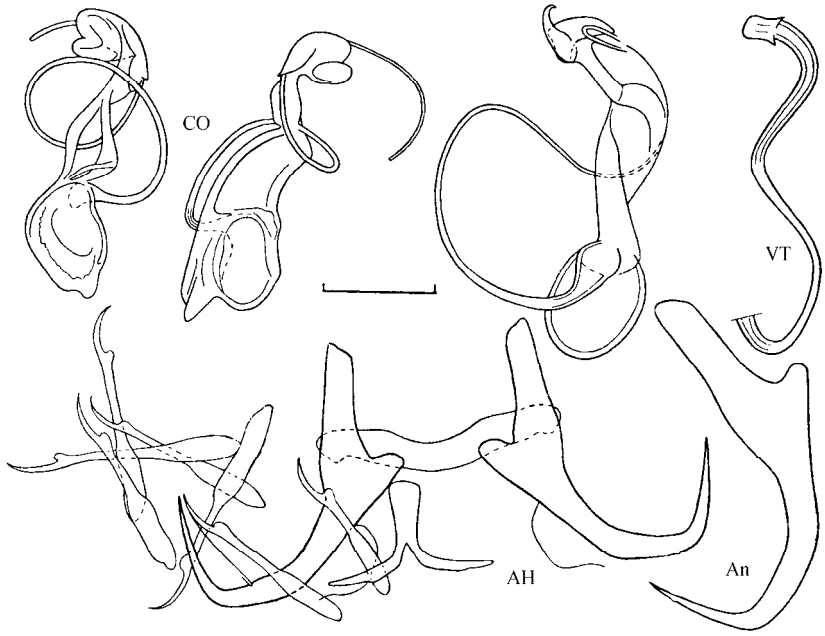


127

Fig. 125 – 127.
125 - *Dactylogyrus difformis*. **126 -** *Dactylogyrus difformoides*. **127-** *Dactylogyrus haplogonus.*



128



129

Fig. 128 – 129.
128 - *Dactylogyrus haplogonoides*: A – from Morava River (Czechia), B – from Tisa River.
129 - *Dactylogyrus izjumovae* from Tisa River (after Gussev, 1966b).

205 (206). The tube of the copulatory organ is short, slightly longer than the accessory piece, not longer than 0.065 mm (without the projection) along the curve, and slightly tapering to its end. Found mostly in the basin of the Caspian Sea.

D. haplogonus Bychowsky, 1933 (Fig. 127)

These are small or medium size worms; body can be up to 0.6 mm long and 0.12 mm wide. Length of marginal hooks is 0.024–0.037 mm. Length of anchors is 0.041–0.050 mm, main part 0.038–0.041 mm, inner root 0.011–0.014 mm, outer root 0.003–0.007 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.004–0.007 x 0.031–0.039 mm, ventral bar 0.018–0.027 x 0.029–0.032 mm. Length of copulatory organ with projection of the initial part is 0.045–0.083 mm, without it 0.040–0.053 mm.

Found on gill filaments of *Vimba vimba* (and *Alburnus chalcoides*?); rivers of the Caspian Sea Basin. Pashkevichute (1971) found it in the lower reach of the Dnieper River.

206 (205). The tube of the copulatory organ is long (twice as or longer than the accessory piece, greater than 0.12 mm along the curve). It forms about two spires and tapers to the end.

D. haplogonoides Gussev, 1966 (Fig. 128)

These are small or medium size worms; body length can be up to 0.6 mm and width to 0.15 mm. Length of marginal hooks is 0.023–0.040 mm. Length of anchors is 0.042–0.051 mm, main part 0.036–0.043 mm, inner root 0.010–0.015 mm, outer root 0.003–0.006 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.004–0.007 x 0.030–0.040 mm, ventral bar 0.018–0.020 x 0.023–0.027 mm. Total length of copulatory organ with projection of the initial part is 0.065–0.105 mm, without it 0.120–0.135 mm along the curve.

Found on gill filaments of *Vimba vimba*; basins of the Danube and Elbe Rivers.

207 (204). The ventral bar lacks a posterior projection; in its places is a dent in the middle of the posterior edge. The tube of the copulatory organ lacks a projection but has a semicircular comb or a thickened edge of its rounded initial part. Vaginal armament is present.

208 (209). The tube of the copulatory organ is greater than 0.060 mm along the curve forming a spiral, which has about two spires; its bubble-shaped initial part has a thickened edge. The vaginal armament is a long bent tube. This is a parasite of *Scardinius erythrophthalmus*.

D. izjumovae Gussev, 1966 (Fig. 129)

These are small worms; body can be up to 0.4 mm long and 0.10 mm wide. Length of marginal hooks is 0.015–0.026 mm. Length of anchors is 0.026–0.031 mm, main part 0.019– 0.023 mm, inner root 0.010–0.012 mm, outer root 0.003–0.004 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.003 x 0.020–0.023 mm, ventral bar 0.008–0.010 x 0.015–0.021 mm. Total length of copulatory organ is 0.023–0.040 mm, tube 0.060–0.075 mm along the curve. Vaginal tube is 0.039–0.045 (Mikailov, 1975: 0.013–0.014) mm.

Found on gill filaments of *Scardinius erythrophthalmus*; it has been found in the basins of the Volga, Kura, Danube, and Oder Rivers and in southern France.

209 (208). The tube of the copulatory organ is less than 0.055 mm along the curve; its initial widening usually has a semicircular comb. The vaginal armament consists of two bubbles that are joined by a short tube; its length is less than 0.020 mm. This is a parasite of *Ballerus ballerus*.

D. chranilowi Bychowsky, 1931 (Fig. 130)

These small or medium size worms have a body length up to 0.6 mm and width to 0.08 mm. Length of marginal hooks is 0.025–0.040 (specimens from fingerlings 0.018–0.026) mm. Length of anchors is 0.042–0.048 (0.039) mm, main part 0.033–0.038 (0.033) mm, inner root 0.014–0.016 (0.010) mm, outer root 0.003–0.005 (0.003) mm, point 0.015–0.019 (0.012) mm. Size of dorsal bar is 0.005–0.006 (without posterior limbus) x 0.035–0.038 (0.003 x 0.029) mm, ventral bar 0.013–0.016 x 0.023–0.030 (0.012 x 0.022) mm. Length of copulatory organ is 0.040–0.050 (0.038) mm, vaginal tube (between “bubbles”) 0.012–0.015 mm.

Found on gill filaments of *Ballerus ballerus* and *Abramis brama* (?); basins of Caspian and

Black Seas.

210 (203). The tube of the copulatory organ is **S** (or inverted **S**) shaped.

211 (212). The anterior and posterior parts of the copulatory organ tube are widened; the latter has a small supporting growth. Vaginal armament is absent. These are parasites of *Ballerus sapa.*
D. propinquus Bychowsky, 1931 (Fig. 131)

These are medium or large size worms; body can be up to 1.0 mm long and 0.2 mm wide. Length of marginal hooks is 0.023–0.032 mm. Length of anchors is 0.043–0.055 mm, main part 0.034–0.043 mm, inner root 0.013–0.020 (Ergens and Lom, 1970: 0.017–0.025) mm, point 0.013–0.018 mm. Size of dorsal bar is 0.004–0.006 x 0.030–0.038 mm, ventral bar 0.012–0.021 x 0.017–0.026 mm. Length of copulatory organ is 0.025–0.034 mm.

Found on gill filaments of *Ballerus sapa* and *B. s. bergi* n. aralensis, *Abramis brama* (?); water bodies of the Black, Caspian, and Aral Seas Basins; several lakes near St.Petersburg.

212 (211). The anterior part of the copulatory organ tube lacks an extension; the posterior part of the tube lacks a supporting growth. Vaginal armament is present.
D. balkanicus Dupont et Lambert, 1987 (Fig. 132)

Length of marginal hooks: I: 0.020–0.021 mm, II: 0.021–0.022 mm, the other one 0.023–0.025 mm. Length of anchors is 0.037–0.039 mm, main part 0.030–0.032 mm, outer root 0.006–0.007 mm, inner root 0.011–0.012 mm, point 0.012–0.014 mm. Size of dorsal bar is 0.003–0.004 x 0.024–0.026 mm, ventral bar 0.010 x 0.020–0.021 mm. Length of copulatory organ is 0.031–0.032 mm. Vaginal armament is present.

Found on gills of *Barbus prespensis*; Lake Mikri Prespa (Greece).

213 (202). The accessory piece of the copulatory organ is more complicated.

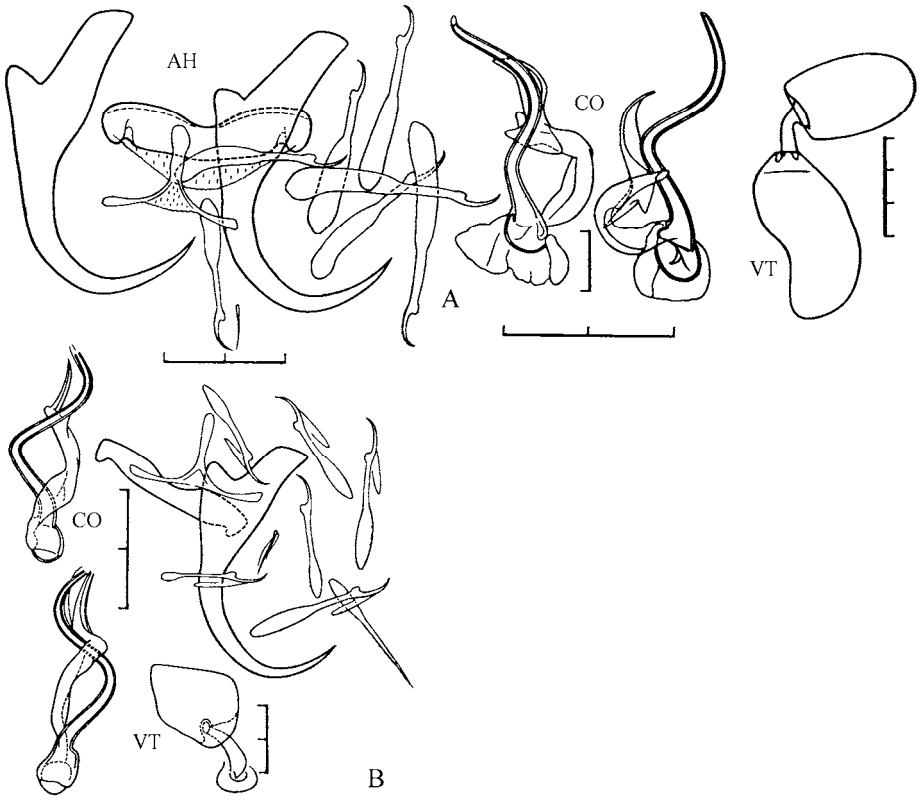
214 (246). The ventral bar lacks a posterior projection. The copulatory organ can be of different types. The vaginal armament is bubble or horn shaped or like a short tube with a narrowing and a cap.

215 (221). The copulatory organ is of the "kulwieci" type.

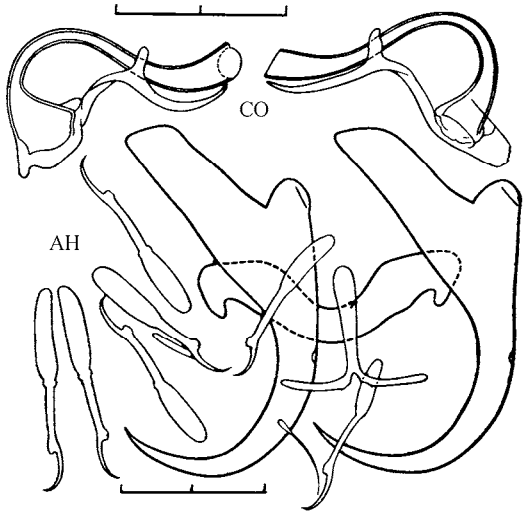
216 (217). The anchors are of the “wunderi” type. The ventral bar is massive with a broad anterior projection. The vaginal armament is bubble shaped (perhaps a seminal receptacle?) with a saddle-shaped added piece. These are parasites of *Barbus petenyi* and *B. kubanicus.*
D. petenyi Kastak, 1957 (Fig. 133)

These are small worms; body is about 0.5 mm long and 0.10 mm wide. Length of marginal hooks is 0.025–0.035 mm. Length of anchors is 0.042–0.044 mm, main part 0.030– 0.034 mm, inner root 0.013–0.016 mm, outer root 0.004–0.005 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.003–0.005 x 0.030–0.035 mm, ventral bar 0.015–0.018 x 0.026–0.032 mm. Total length of copulatory organ is 0.030–0.039 mm. Size of bubble-shaped vaginal armament is 0.011–0.016 mm.

Found on gill filaments of *Barbus petenyi* and *B. kubanicus*; basins of the Danube and Kuban’ Rivers.

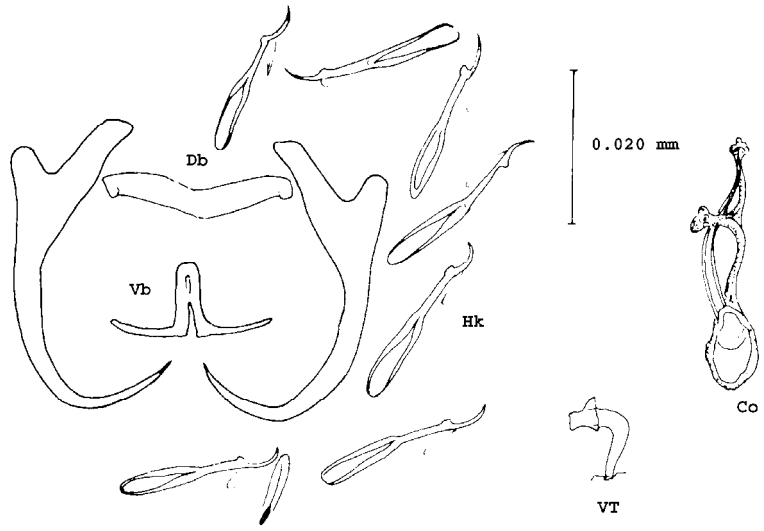


130

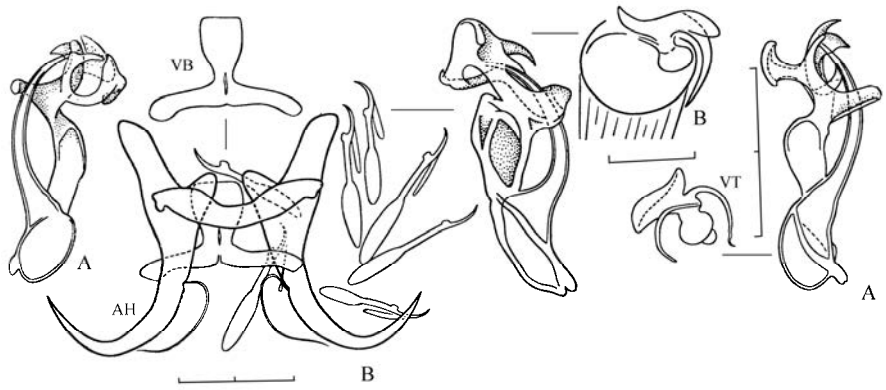


131

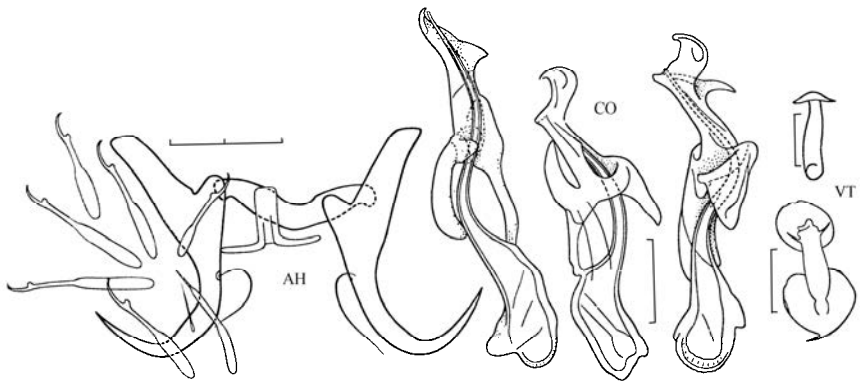
Fig. 130 – 131.
130 - *Dactylogyrus chranilovi* from Volga River: A – from adult *Ballerus ballerus*, B - from young fish. **131 -** *Dactylogyrus propinquus* from Latorica River (Slovakia).



132



133



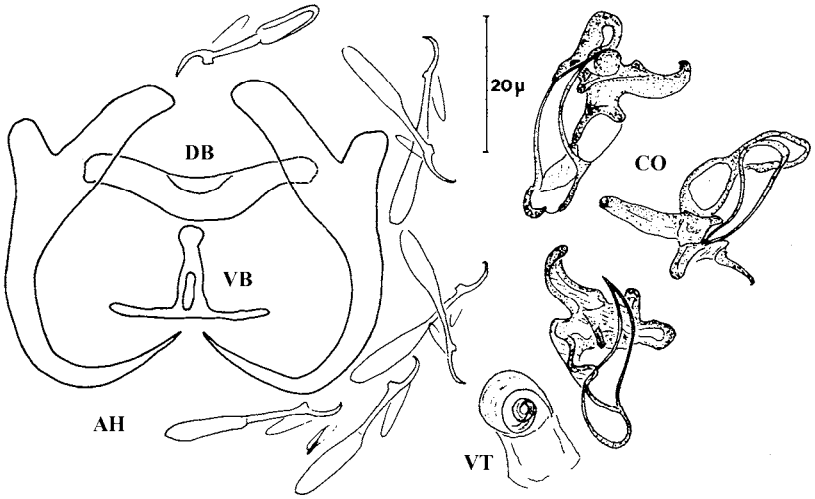
134

Fig. 132 – 134.
132 - *Dactylogyrus balkanicus* (after Dupont and Lambert, 1987). **133 -** *Dactylogyrus petenyi* A - from *Barbus kubanicus* (Kuban' River, Russia), B - from *Barbus petenyi* (Hungary). **134 -** *Dactylogyrus dyki* from *Barbus barbus* (Tisa River).

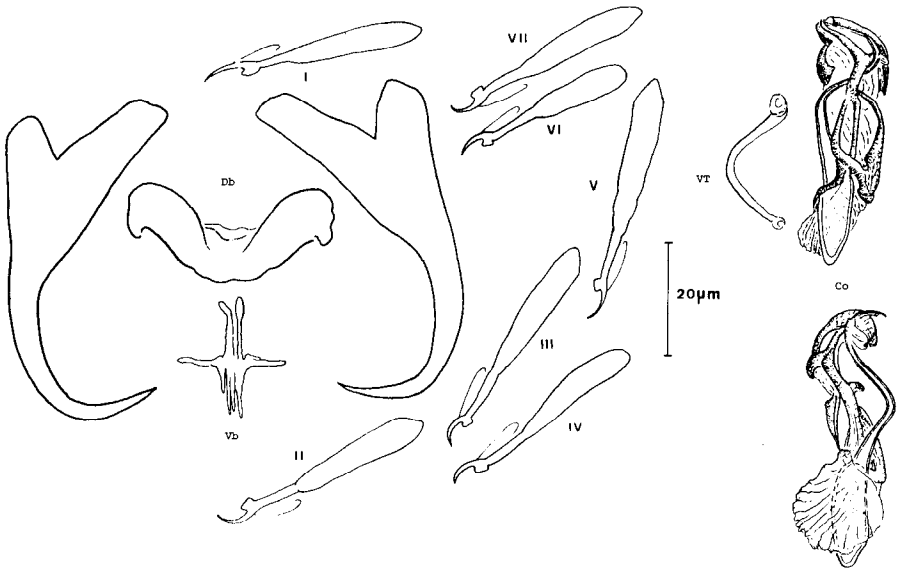
217 (218). The anchors are of the "wunderi" type. The ventral bar is rather thin with a slightly broadened anterior projection. A fungiform vaginal armament is present. These are parasites of *Barbus barbus* and *B. petenyi*.

D. dyki Ergens et Lucky, 1959 (Fig. 134)

These are small worms; body is about 0.5 mm long and 0.10 mm wide. Length of marginal hooks is 0.019–0.026 mm. Length of anchors is 0.039–0.046 mm, main part 0.028– 0.034 mm, inner root 0.013–0.020 mm, outer root 0.002–0.005 mm, point 0.015–0.019 mm. Size of dorsal bar is 0.003–0.005 x 0.028–0.034 mm, ventral bar 0.008–0.012 x 0.018–0.022 mm. Total length of copulatory organ is 0.039–0.045 mm. Length of vaginal tube is 0.012–0.016 mm, small discal plates are present at both its ends.



135



136

Fig. 135 – 136.
135 - *Dactylogyrus prespensis* (after Dupont et Lambert, 1987). **136 -** *Dactylogyrus andalousiensis* (after El Gharbi et al., 1992).

Found on gill filaments of *Barbus barbus* and *B. petenyi*; basins of the Danube, Elbe, and Oder Rivers. Paperna (1961) found it on *Capoeta damascina* in Israel, but this specimen seems not to be *D. dyki*, but *D. linstowi* ("large" form). This conclusion was made after studying his drawings and slides.

218 (219). The anchors are of the “wunderi” type. The anterior projection of the ventral bar has extension at the end only.

D. prespensis Dupont et Lambert, 1987 (Fig. 135)

Length of marginal hooks: I: 0.024 mm, II: 0.027 mm, the rest 0.026–0.036 mm. Total length of anchors is 0.045–0.047 mm, main part 0.035–0.036 mm, outer root 0.006 mm, inner root 0.019–0.020 mm, point 0.017–0.018 mm. Size of dorsal bar is 0.006–0.007 x 0.032–0.033 mm, ventral bar 0.013–0.014 x 0.021–0.023 mm. Length of copulatory organ is 0.031–0.033 mm. Vaginal armament is present.

Found on gills of *Barbus prespensis*; Lake Mikri Prespa, Greece.

219 (218). The anchors are of the “wunderi” type. The ventral bar is ⊥ shaped and has a long fimbriated posterior projection. The accessory piece begins with a fan-shaped plate that lies on the initial part of the copulatory tube.

D. andalousiensis El Gharbi et al., 1992 (Fig. 136)

Body length is 0.997 (0.995–1.127) mm, width 0.120 (0.117–0.124) mm. Length of marginal hooks of I and II pairs is 0.042–0.045 mm and 0.037–0.046 mm for the other one. Length of anchors is 0.059 (0.054–0.064) mm, main part 0.048 (0.044–0.050) mm, inner root 0.009 (0.008–0.010) mm, outer root 0.017 (0.013–0.020) mm. Size of dorsal bar is 0.008 (0.006–0.010) x 0.040 (0.033–0.043) mm, ventral bar 0.019 (0.018–0.022) x 0.023 (0.023–0.025) mm. Length of copulatory organ is 0.051 (0.049–0.053) mm, tube 0.059 (0.055–0.061) mm. Length of vaginal tube is 0.031 (0.030–0.033) mm.

Found on gills of *Luciobarbus microcephalus* and *L. sclateri*; Spain.

221 (215). The copulatory organ is of other types.

222 (227). The copulatory organ is of the "linstowi" or "malleus" type.

223 (224). The haptor and anchors are of the “sphyrna” type, with one pair of well-developed marginal hooks that are directed to the anchor points. The ventral bar is absent.

D. balistae Vicente, 1981 (Fig. 137, 138)

Body length is 0.885 (0.705–0.998) mm, width 0.100 (0.098–0.128) mm. Length of marginal hooks: I: 0.025 (0.022–0.027) mm, II: 0.023 (0.021–0.025) mm, III: 0.031 (0.028–0.033) mm, IV: 0.028 (0.024–0.031) mm, V: 0.028 (0.026–0.030) mm, VI: 0.027 (0.026–0.029) mm, VII: 0.035 (0.032–0.037) mm. Length of anchors is 0.040 (0.037–0.042) mm, main part 0.027 (0.025–0.029) mm, outer root 0.004 (0.003–0.004) mm, inner root 0.019 (0.018–0.022) mm, point 0.020 (0.017–0.024) mm. Size of dorsal bar is 0.028 (0.022–0.031) mm. Length of copulatory organ is 0.047 (0.045–0.050) mm. Length of vaginal tube is 0.008 (0.007–0.010) mm.

Found on gills *Luciobarbus bocagei, L. sclateri,* and *L. comizo*; Spain.

224 (225). The copulatory organ is of the "linstowi" type. The vaginal armament is like a small tube with two plates on its ends. The length of the anchors is greater than 0.046 mm. These are parasites of fish of subfamilies Barbinae and Schizotoracinae.

D. linstowi Bychowsky, 1936 (Fig. 139)

These are small worms; body length can be up to 0.5 mm and width to 0.12 mm. Length of marginal hooks is 0.022–0.030 mm. Length of anchors is 0.046–0.050 mm, main part 0.032–0.039 mm, inner root 0.015–0.019 mm, outer root 0.004–0.005 mm, point 0.014–0.017 mm. Size of dorsal bar is 0.004–0.007 x 0.028–0.033 mm, ventral bar 0.012–0.017 x 0.024–0.030 mm. Total length of copulatory organ is 0.035–0.056 mm. Length of vaginal tube is about 0.007 mm with small plates on its ends.

Two types exist: one has small chitinoid structures and the other has larger ones; the difference in the length of the copulatory organ is especially visible (Gussev, 1966).

Found on gill filaments of *Luciobarbus capito conocephalus, L. brachycephalus, Schizotorax intermedius, S. pseudaksaiensis,* and *S. p. issykkuli* in water bodies of Central Asia and Kazakhstan; of *Luciobarbus brachycephalus caspius, L. capito, Barbus lacerta cyri,* and *B. mursa* in water bodies of Azerbaidjan, Israel.

225 (226). The copulatory organ is of the "linstowi" type. The length of the anchors is less than 0.042 mm.

D. linstowoides El Gharbi et al., 1992 (Fig. 140)

Body length is 0.350 (0.264–0.441) mm and width 0.081 (0.049–0.098) mm. Length of marginal hooks: I: 0.023 (0.022–0.026) mm, II: 0.026 (0.024–0.027) mm, III: 0.025 (0.023–0.027) mm, IV: 0.025 (0.024–0.027) mm, V: 0.026 (0.025–0.028) mm, VI: 0.029 (0.029–0.031) mm, VII: 0.026 (0.026–0.027) mm. The length of the anchors is 0.040 (0.038–0.042) mm, main part 0.032 (0.030–0.034) mm, outer root 0.005 (0.004–0.007) mm, inner root 0.017 (0.016–0.018) mm, point 0.015 (0.013–0.017) mm. Size of dorsal bar is 0.005 (0.004–0.007) x 0.025 (0.024–0.027) mm, ventral bar 0.013 (0.012–0.016) x 0.023 (0.017–0.026) mm. Length of copulatory organ is 0.048 (0.037–0.051) mm, length of vaginal tube 0.007 (0.007–0.008) mm.

Found on gills of *Luciobarbus guiraonis* and *L. graellsii*; Spain.

226 (225). The copulatory organ is of the "malleus" type. The vaginal armament is a folded structure that is thickened and bent like a "**?**". These are parasites of the genera *Barbus* and *Luciobarbus.*

D. malleus Linstow, 1877 (Fig. 141)

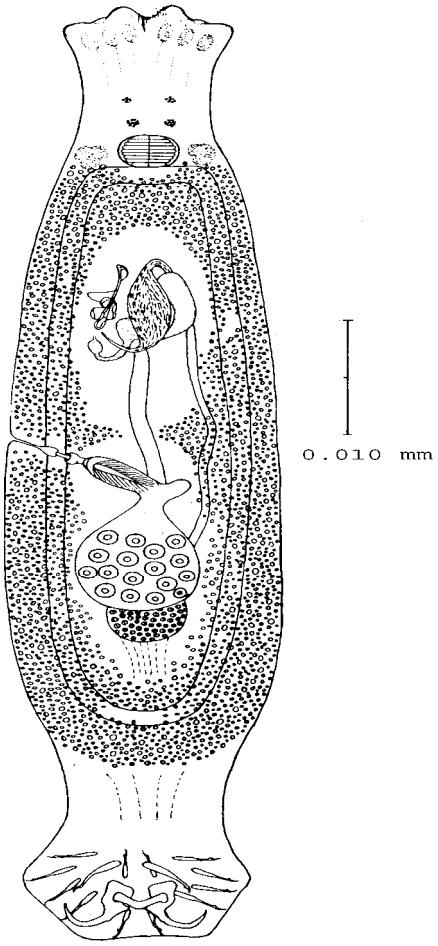


Fig. 137 - *Dactylogyrus balistae,* total view (after Vicente, 1981).

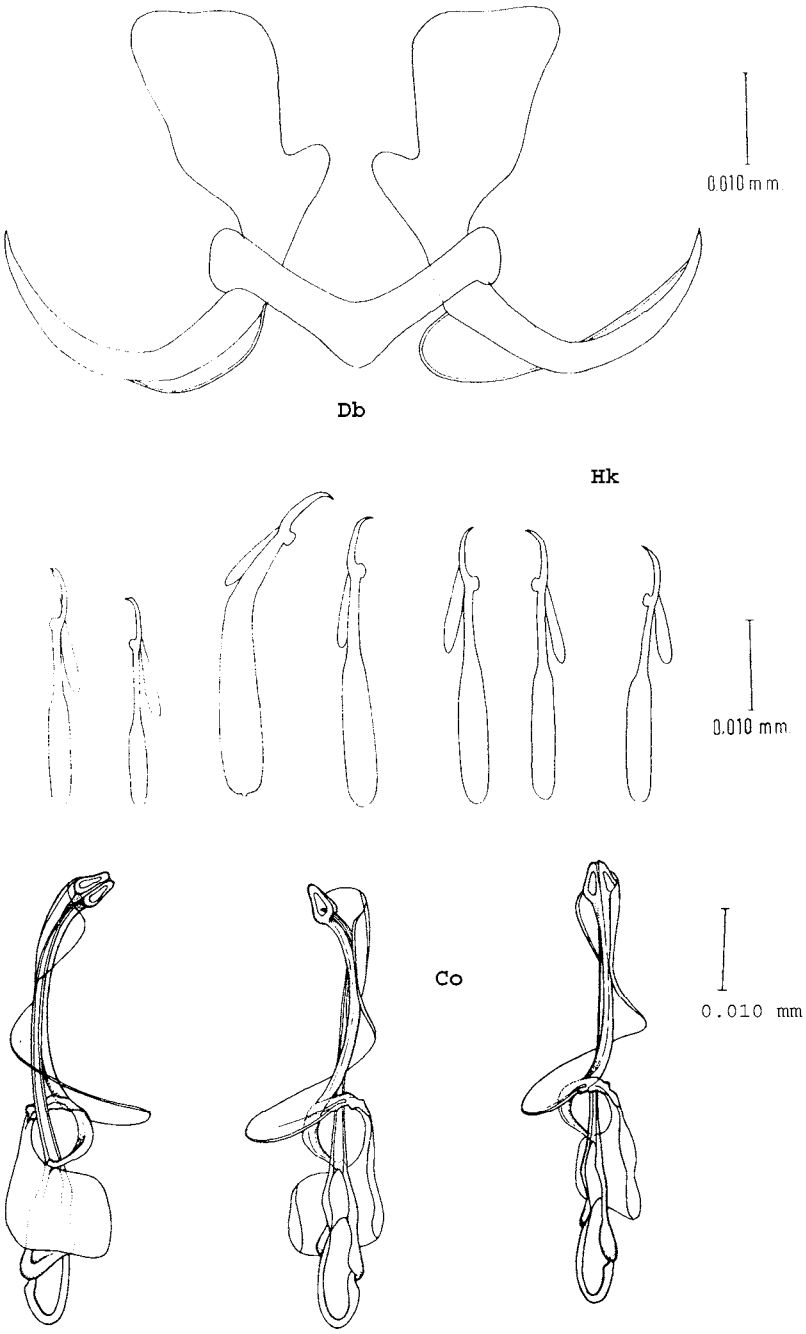


Fig. 138- *Dactylogyrus balistae* (after Vicente, 1981)

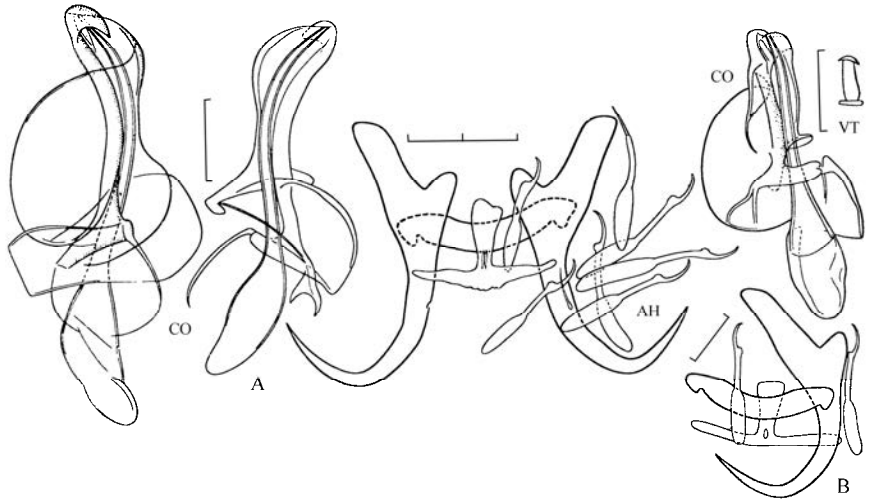


Fig. 139 - *Dactylogyrus linstowi*: A – "large" form from *Schizothorax intermedius*, B – "small" form from *Luciobarbus capito conocephalus*.

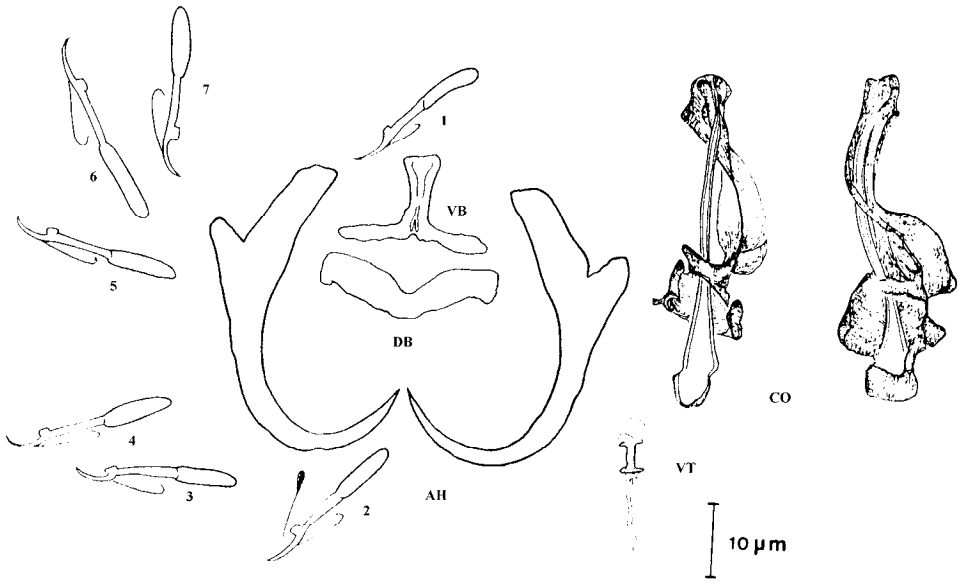
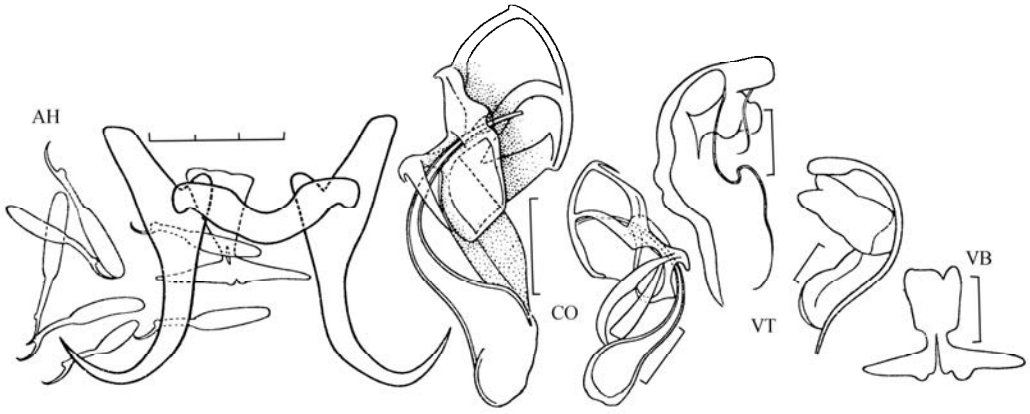
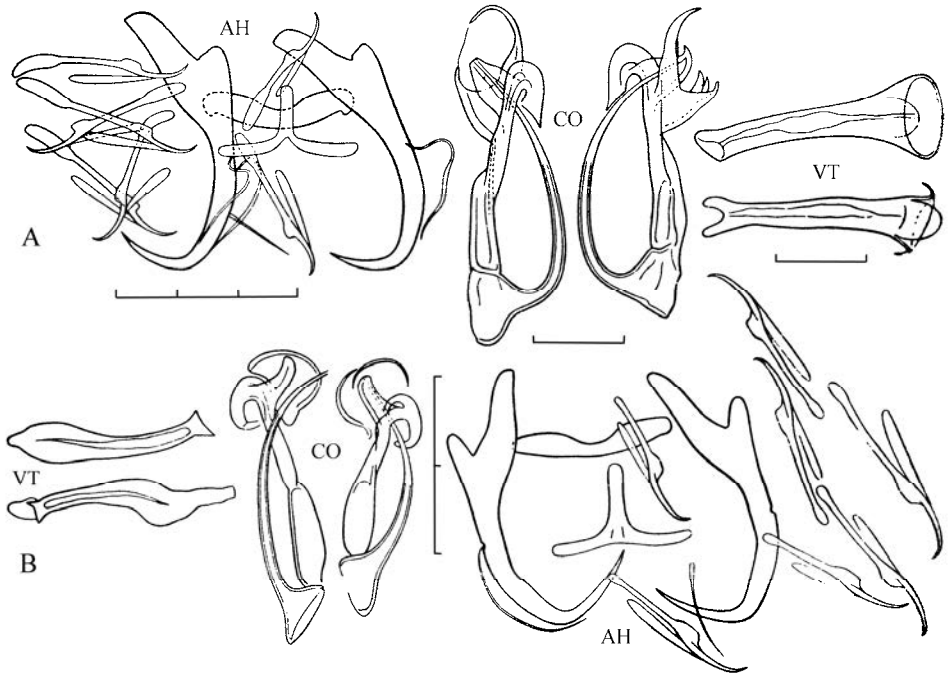


Fig. 140 - *Dactylogyrus linstowoides* (after El Gharbi et al., 1992).



141



142

Fig. 141 – 142.
141 - *Dactylogyrus malleus* from *Barbus barbus* (Dnestr and Tisa Rivers). **142** - *Dactylogyrus ramulosus*: A – from *Leuciscus idus* (Iriklinskoye Reservoir, River Ural, Russia), B – from *Leuciscus leuciscus baicalensis* (Abakan River, Siberia, Russia).

These are small or medium size worms; body can be up to 0.6 mm long and 0.11 mm wide. Length of marginal hooks is 0.024–0.036 mm. Length of anchors is 0.051–0.061 mm, main part 0.042–0.050 mm, inner root 0.019–0.024 mm, outer root 0.005–0.008 mm, point 0.017–0.019 mm. Size of dorsal bar is 0.004–0.008 x 0.035–0.041 mm, ventral bar 0.021– 0.026 x 0.029–0.038 mm. Length of copulatory organ is 0.035–0.043 mm. Length of vaginal folded armament is 0.034–0.048 mm.

Found on gill filaments of *Barbus barbus, B. peteneyi*, and *Luciobarbus brachycephalus caspicus*; basin of Black Sea; Elbe and Oder Rivers; estuary of the Rhone River (France).

Agapova (1966) and Mikailov (1975) erroneously reported it from the Aral Sea Basin because Dogiel et Bychowsky (1934) made the same error, mistaking *D. linstowi* for *D. malleus*. There are no publications on its occurrence to the east of the Caspian Sea.

227 (221). The copulatory organ is of other types.

228 (233). The copulatory organ is of the "ramulosus" type.

229 (232). The vaginal armament is in the form of a massive broad tube or grain–shaped structure. The broadened initial part of the copulatory tube is in the form of a triangular funnel.

230 (231). The vaginal tube is slightly widened at one end and horn shaped at the other. The marginal hooks have a flattened heel of the point.

D. ramulosus Malewitzkaja, 1941 (Fig. 142, 268)

These are small worms; body length can be up to 0.5 mm, width to 0.10 mm. Length of marginal hooks is 0.017–0.032 mm. Length of anchors is 0.029–0.045 mm, main part 0.021–0.037 mm, inner root 0.008–0.011 mm, outer root 0.002–0.004 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.002–0.005 x 0.018–0.025 (in first description 0.026–0.029) mm, ventral bar 0.009–0.011 x 0.015–0.023 mm. Length of copulatory organ is 0.028–0.040 mm, vaginal tube 0.022–0.028 (0.029–0.035) mm.

Found on gill filaments of *Leuciscus idus, L. waleckii, L. leuciscus, L. l. baicalensis, Rutilus rutilus,* and *R. r. lacustris*; basins of Black, Caspian, Baltic, and White Seas, water bodies of western Siberia, Pechora and Amur Rivers.

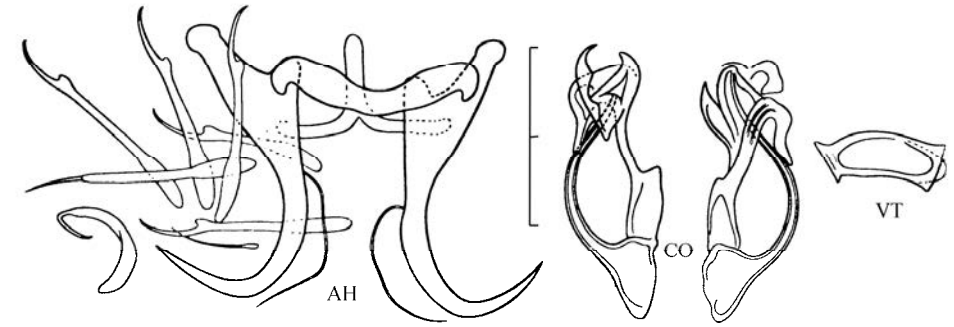
The length of the worm was listed as up to 1.5 mm in the first description. Perhaps this error occurred because *D. micracanthus* can be erroneously identified as *D. ramulosus*. All following fish parasitologists noted that *D. ramulosus* is a small worm. Western Siberian specimens and those from the Amur River differ from European specimens by having smaller chitinoid structures: marginal hooks 0.016–0.023 mm, anchors 0.029–0.032 mm, dorsal bar 0.009 x 0.015–0.019 mm.

231 (230). The vaginal armament is in the form of a small grain-shaped structure. The marginal hooks have a rounded heel of the point.

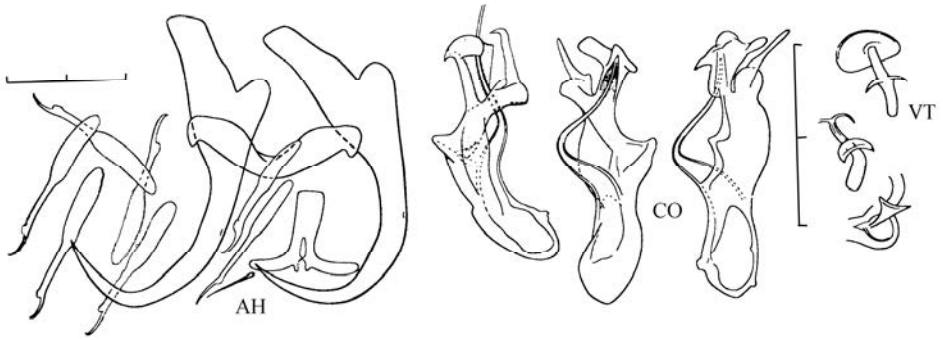
D. micracanthus Nybelin, 1937 (Fig. 143)

Syn.: *D. caecus* Kulakowskaja in Gussev, 1962

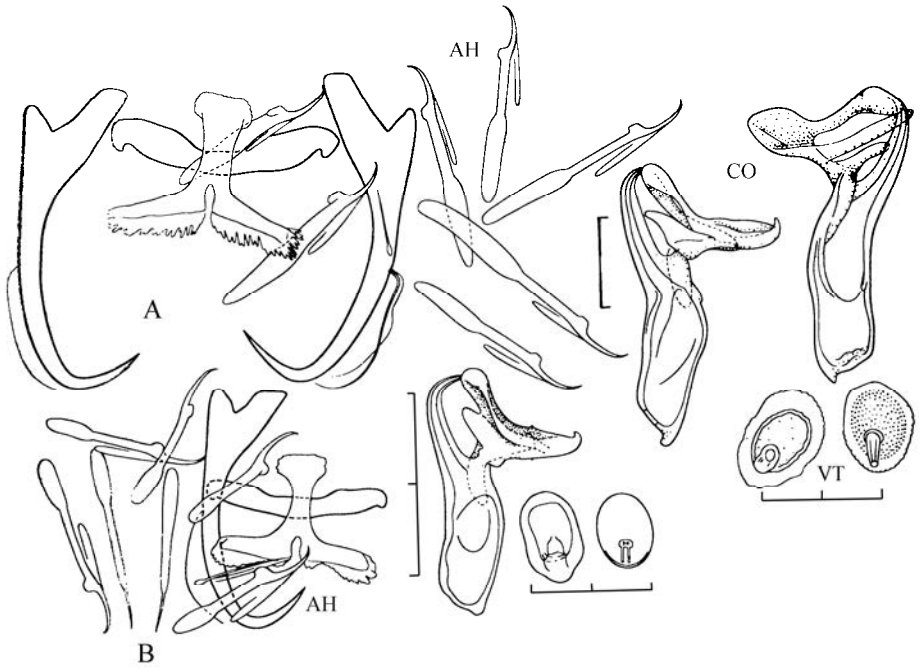
These are medium size or large worms; body can be up to 0.8 mm long and 0.2 mm wide (up to 1.9 and 0.44 mm after personal communication of Kulakowskaja). Length of marginal hooks is 0.016–0.026 mm. Length of anchors is 0.024–0.033 mm, main part 0.012–0.025 mm, inner root 0.009–0.011 mm, outer root 0.003–0.004 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.002–0.004 x 0.017–0.025 mm, ventral bar 0.008–0.011 x 0.016–0.020 mm. Length of copulatory organ is 0.025–0.030 mm, vaginal armament 0.011–0.016 mm.



143



144



145

Fig. 143 – 145.
143 - *Dactylogyrus micracanthus* from *Squalius cephalus* (Dnestr River). **144 -** *Dactylogyrus prostae* (partly after Ergens et Gussev, 1965). **145 -** *Dactylogyrus fraternus* (Lake Vrevo, Leningrad region, Russia): A – from adult *Alburnus alburnus*, B – from young fish.

Found on gill filaments of *Rutilus rutilus*, *R. r. lacustris*, *Leuciscus idus*, *Squalius cephalus*, and *Scardinius erythrophthalmus* (?); basins of the Black and Baltic Seas, water bodies of western Siberia, Pechora River.

D. ramulosus and *D. micracanthus* are very similar to one another; found rarely and in small amounts.

232 (229). The vaginal armament is in the form of a small fungiform structure. The widened initial part of the copulatory organ tube is shoe shaped and forward-bent from the adjoined part of the tube.

D. prostae Molnar, 1964 (Fig. 144)

These are small or medium size worms; body can be up to 0.63 mm long and 0.11 mm wide. Length of marginal hooks is 0.021–0.030 mm. Length of anchors is 0.040–0.051 mm, main part 0.029–0.040 mm, inner root 0.012–0.019 mm, outer root 0.003–0.005 mm, point 0.014–0.017 mm. Size of dorsal bar is 0.004–0.006 x 0.023–0.032 mm, ventral bar 0.012– 0.017 x 0.016–0.022 mm. Length of copulatory organ is 0.026–0.032 mm, vaginal armament about 0.010 mm.

Found on gill filaments of *Squalius cephalus* and *Squalius cephalus orientalis*; basins of the Danube, Elbe, and Oder Rivers, Lake Skadar; water bodies of southern France, Italy, Iran.

233 (228). The copulatory organ is of the "nanus" type.

234 (237). The vaginal armament is in the form of a round plate with a short tube starting in the middle.

235 (236). The ventral bar is rather massive; its transverse wings have a fringe at their posterior edge; the anterior projection has a rectangular widening at its end. These are parasites of *Alburnus.*

D. fraternus Wegener, 1910 (Fig. 145)

These are small worms; body can be up to 0.45 mm long and 0.11 mm wide. Length of marginal hooks is 0.019–0.028 (specimens from fingerlings 0.015–0.020) mm. Length of anchors is 0.030–0.038 (0.025–0.027) mm, main part 0.025–0.029 (0.023–0.024) mm, inner root 0.006–0.011 (0.003–0.005) mm, outer root 0.003–0.004 mm, point 0.007–0.008 (0.006–0.007) mm. Size of dorsal bar is 0.002–0.003 x 0.023–0.026 (0.002 x 0.020) mm, ventral bar 0.013–0.016 x 0.018–0.021 (0.008–0.012 x 0.018) mm. Length of copulatory organ is 0.029–0.034 (0.020–0.028) mm, vaginal armament 0.015–0.018 x 0.011–0.012 mm.

Found on gill filaments of *Alburnus alburnus*, *A. hohenackeri*, *Alburnoides taeniatus* (?), and *Leucaspius delineatus* (?); distributed everywhere in the area of the genus *Alburnus*; southern France; on *A. alborella* (former Yugoslavia).

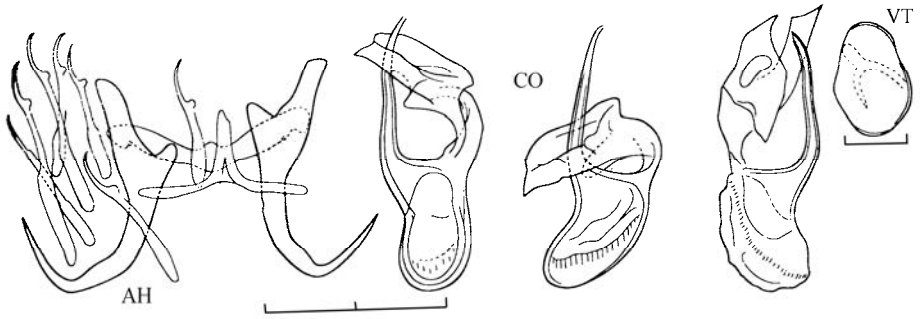
236 (235). The ventral bar is thin and lacks a fringe and a widening on the end of the anterior projection. These are parasites of *Alburnoides taeniatus*.

D. neoparvus Osmanov, 1965 (Fig. 146)

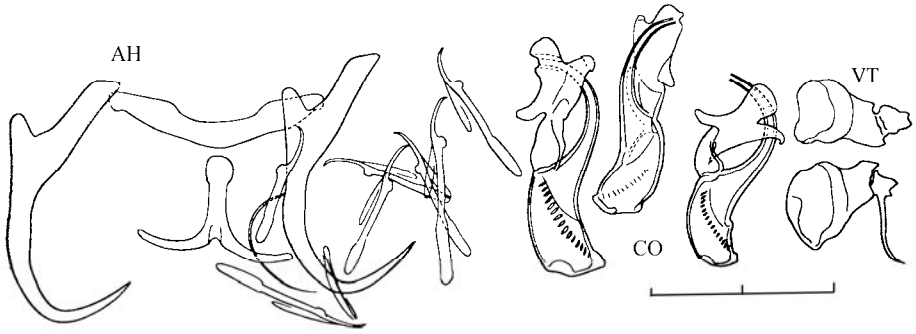
Syn.: *D. parvus* in Ergens, 1970 (?); *D. agapovae* in Allamuratov, 1966

These worms are minute; body length is about 0.2 mm, width 0.04 mm. Length of marginal hooks is 0.013–0.025 mm. Length of anchors is 0.025–0.028 mm, main part 0.018–0.020 mm, inner root 0.008–0.011 mm, outer root 0.002–0.003 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.022–0.025 mm, ventral bar 0.008 x 0.016–0.019 mm. Length of copulatory organ is 0.025–0.033 mm, vaginal armament 0.012 x 0.019 mm.

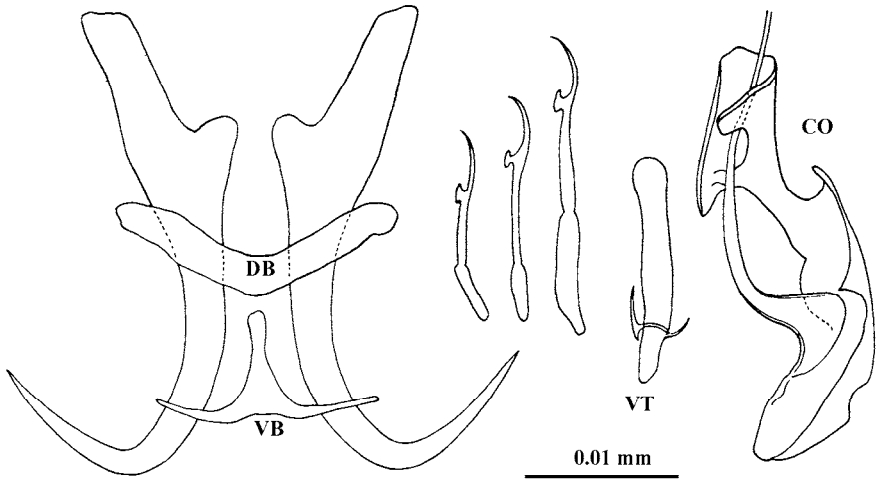
Found on gill filaments of *Alburnoides taeniatus*; rivers of Central Asia; perhaps found also on *Alburnus alborella* from former Yugoslavia.



146



147



148

Fig. 146 – 148.
146 - *Dactylogyrus neoparvus* from *Alburnoides taeniatus* (Uzbekistan). **147 -** *Dactylogyrus parvus* from *Alburnus alburnus* (Lake Vrevo, Leningrad region, Russia). **148 -** *Dactylogyrus rosickyi* (after Ergens, 1970).

237 (234). The vaginal armament is a short and sometimes bent tube.

238 (239). The vaginal armament is in the form of broad short funnel-shaped tube with a thin projection; the tube with this projection sometimes forms a **Y**- or **V**–shaped figure. These are parasites of fishes of the genus *Alburnus*.

D. parvus Wegener, 1910 (Fig. 147)

These are minute worms; body length can be up to 0.3 mm, width 0.06 mm. Length of marginal hooks is 0.013–0.023 mm. Length of anchors is 0.023–0.028 mm, main part 0.016–0.020 mm, inner root 0.007–0.009 mm, outer root 0.002–0.004 mm, point 0.008–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.020–0.023 mm, ventral bar 0.008–0.010 x 0.014–0.017 mm. Length of copulatory organ is 0.020–0.027 mm, vaginal "funnel" 0.009–0.011 mm.

Found on gill filaments of *Alburnus alburnus* and *A. hohenackeri*; basins of the Black, Caspian, and Baltic Seas; southern France; *A. alborella* (former Yugoslavia (?)).

Finds of this species on *Squalius cephalus* seem to be an error. Other species (*D. prostae*, *D. nanoides*, or *D. folkmanovae*) were identified as *D. parvus*.

239 (245). The vaginal armament is in the form of a short or medium size cylindrical bent tube, sometimes with a pinch, closed with a cap[26].

240 (241). The total length of the anchors is less than 0.032 mm; point length is not less than 0.01 mm. The anterior projection of the ventral bar has a triangular form and narrows to the end. The marginal hooks of different pairs vary in length.

D. rosickyi Ergens, 1970 (Fig. 148)

Length of marginal hooks is 0.012–0.021 mm. Total length of anchors is 0.026–0.030 (at the average 0.029) mm, main part 0.020–0.023 (0.023) mm, outer root about 0.002 mm, inner root 0.009–0.010 (0.010) mm, point 0.010–0.011 (0.011) mm. Size of dorsal bar is 0.002–0.003 x 0.017–0.020 (0.003–0.020) mm, ventral bar 0.006 x 0.012–0.015 (0.015) mm. Total length of copulatory organ is 0.028–0.030 (0.030) mm. Length of vaginal armament is 0.013–0.015 (0.015) mm.

Found on gills of *Pachychilon pictum*; Lake Skadar, former Yugoslavia.

241 (244). The total length of the anchors in most cases is less than 0.032 mm. The anterior projection of the ventral bar is only 1.5–2 times thicker than its lateral wings. The tube of the copulatory organ has thin walls, and it is smoothly bent all along its length from the initial part.

242 (243). The length of the anchor point is less than 0.007 mm; the inner root is less than twice as long as the outer root. These are parasites of *Rutilus*.

D. nanus Dogiel et Bychowsky, 1934 (Fig. 149)[27]

Syn.: *D. gemellus* Nybelin, 1937

These are very small worms; body can be up to 0.4 mm long and 0.1 mm wide. Length of marginal hooks is 0.016–0.025 mm. Length of anchors is 0.027–0.035 (from fingerlings 0.023–0.029)mm, main part 0.024–0.028 mm, inner root 0.004–0.009 mm, outer root 0.003–0.005 mm, point 0.005–0.006 mm. Size of dorsal bar is 0.002–0.004 x 0.016–0.022 mm, ventral bar 0.008–0.011 x 0.013–0.019 mm. Length of copulatory organ is 0.024–0.029 (from fingerlings 0.022–0.026) mm, vaginal tube 0.008–0.015 mm.

[26] Species joined by this thesis and thesis 246 as well as *D. folkmanovae* are difficult to identify because of poor quality slides made with poorly pressed objects.

[27] See remark to thesis 239.

Fig. 149. *Dactylogyrus nanus*:
A – from Elbe River (Czechia), B - from Tisa River, C – from ***Rurilus rutilus*** larval stage (Lake Seliger, Russia).

Found on gill filaments of ***Rutilus rutilus***, ***R. r. aralensis***, ***R. r. heckelii***, ***R. r. lacustris***, and ***R. caspicus***; it seems to be present in all water bodies where ***Rutilus*** is present. Information on finds of ***D. nanus*** on other fish genera are to be attributed to other species of ***Dactylogyrus*** that have been confused with ***D. nanus*** (see host–parasite list).

243 (242). The length of the anchor point is greater than 0.008 mm; the inner root is greater than 2.5 times longer than the outer root. This is a parasite of ***Squalius cephalus***.
D. nanoides Gussev, 1966 (Fig. 150)[28]

[28] See remarks to thesis 239.

These are minute worms; body can be up to 0.3 mm long and 0.07 mm wide. Length of marginal hooks is 0.014–0.025 mm. Length of anchors is 0.025–0.029 mm, main part 0.023–0.025 mm, inner root 0.007–0.009 mm, outer root 0.003–0.004 mm, point 0.008–0.009 mm. Size of dorsal bar is 0.002–0.003 x 0.017–0.020 mm, ventral bar 0.007–0.009 x 0.013–0.016 mm. Length of copulatory organ is 0.020–0.022 mm, vaginal tube 0.007–0.008 mm.

Found on gill filaments of *Squalius cephalus* and *S. c. orientalis*; described from the Tisa River (Ukraine); according to R. Ergens it also is found in former Yugoslavia on *Squalius cephalus*.

D. nanoides is very similar to *D. nanus* and can be confused with it. This is because there are specimens of typical *D. nanus* that have anchors very similar to those of *D. nanoides*.

244 (241). The length of the anchors is greater than 0.032 (up to 0.042) mm; the anterior projection of the ventral bar is very massive and has horn-like ends that are 2 to 3 times thicker than the transverse wings. The copulatory tube has thick walls; the tube is bent only at its distal end. These are parasites of *Rutilus*.

D. suecicus Nybelin, 1937 (Fig. 151)[29]

These are small worms; body can be up to 0.5 mm long and 0.12 mm wide. Length of marginal hooks is 0.021–0.033 mm. Length of anchors is 0.032–0.042 mm, main part 0.027–0.033 mm, inner root 0.007–0.015 mm, outer root 0.003–0.007 mm, point 0.008–0.010 mm. Size of dorsal bar is 0.004–0.006 x 0.027–0.031 mm, ventral bar 0.013–0.018 x 0.021–0.029 mm. Length of copulatory organ is 0.025–0.032 mm, vaginal tube 0.013–0.020 mm.

Found on gill filaments of *Rutilus rutilus, R. r. aralensis, R. r. lacustris,* and *Abramis brama* (?); its distribution seems to be concomitant with those of its hosts.

245 (239). The vaginal armament is in the form of a long thin coiled tube that is closed with a cap. The tube of the copulatory organ is **S** (or inverted **S**) shaped.

D. sekulovici Ergens, 1970 (Fig. 152).

Length of marginal hooks is 0.012–0.023 mm. Total length of anchors is 0.026–0.030 (at the average 0.030) mm, main part 0.017–0.020 (0.020) mm, outer root about 0.002 mm, inner root 0.012–0.013 (0.012) mm, point 0.011–0.012 (0.012) mm. Size of dorsal bar is 0.002–0.003 x 0.017–0.022 (0.003 x 0.021) mm, ventral bar 0.011–0.014 (0.013) x 0.015–0.019 (0.018) mm. Total length of copulatory organ is 0.026–0.028 (0.026) mm. Length of vaginal tube is about 0.030 mm.

Found on gills of *Pachychilon pictum*; Lake Skadar, former Yugoslavia.

246 (214). The ventral bar has a short posterior projection[30] with an uneven and poorly visible edge. The copulatory organ is of the "nanus" type. The vaginal tube is **S** (or **C**) shaped.

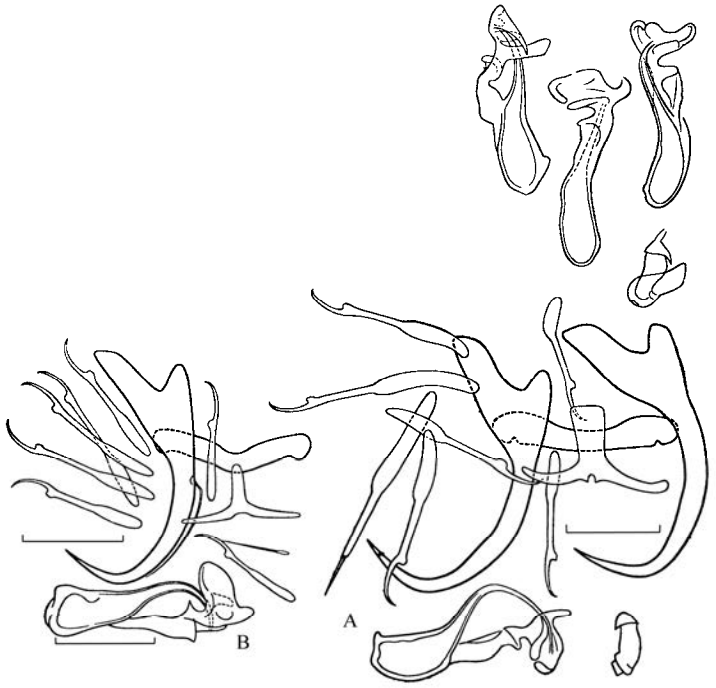
247 (248). The broadened end of the accessory piece of the copulatory organ is like a tight fist. The length of the vaginal tube is greater than 0.030 mm. This is a parasite of *Rutilus*.

D. rutili Glaeser, 1965 (Fig.153)[31]

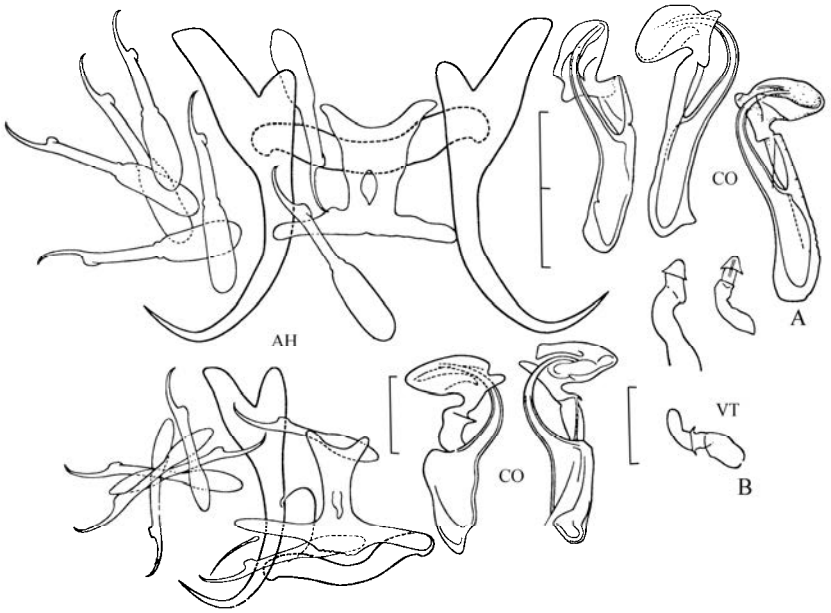
These are small worms; body can be up to 0.4 mm long and 0.08 mm wide. Length of marginal hooks is 0.016–0.028 mm. Length of anchors is 0.025–0.036 mm, main part 0.023–0.031 mm, inner root 0.006–0.008 mm, outer root 0.003–0.005 mm, point 0.005–0.007 mm. Size of dorsal bar is 0.002–0.004 x 0.016–0.021 mm, ventral bar 0.010–0.019 x 0.016–0.022 mm. Length of copulatory organ is 0.023–0.032, vaginal tube along the curve 0.030–0.041 mm.

Found on gill filaments of *Rutilus rutilus* and *Squalius cephalus* (?); found in the Volga, Tisa, Elbe, and Oder Rivers; its distribution seems to be concomitant with that of its hosts.

[29] See remark to thesis 239.
[30] See also theses 92, 135, 190, 204, and 261 and figures of those species.
[31] See remarks to thesis 239.



150

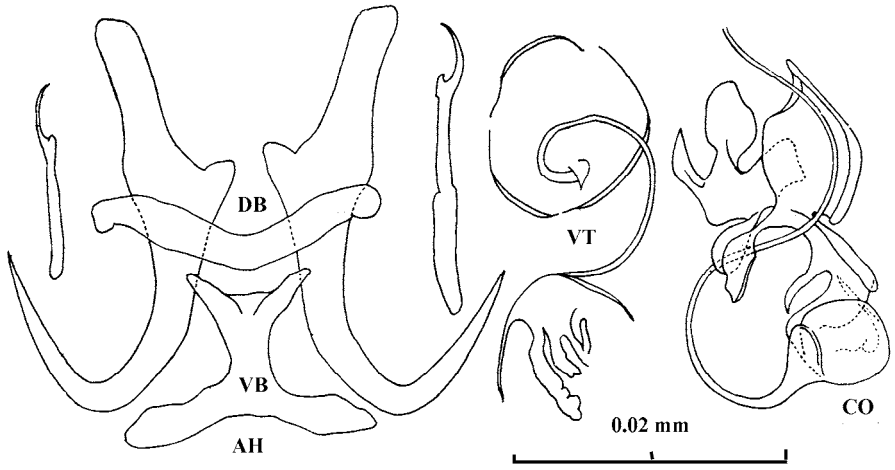


151

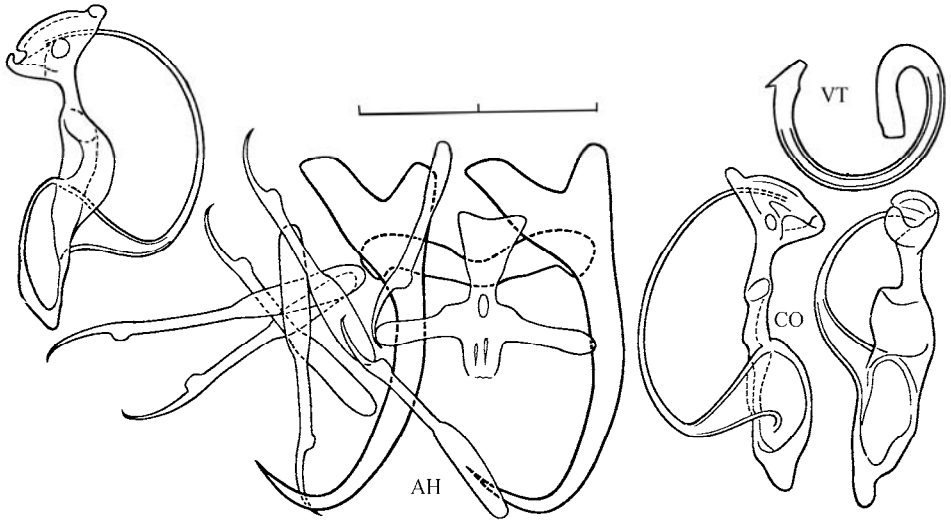
Fig. 150 – 151.

150 - *Dactylogyrus nanoides*; A – from Tisa River, B – from *Squalius cephalus* (Lake Skadar, former Yugoslavia).

151 - *Dactylogyrus suecicus*: A – from adult *Rutilus rutilus* from Tisa River (after Gussev, 1966b), B – from young fish (Lake Seliger, Russia).



152



153

Fig. 152 – 153.
152 - *Dactylogyrus sekulovici* (after Ergens, 1970). **153 -** *Dactylogyrus rutili* from Tisa River (after Gussev, 1966b).

248 (247). The broadened end of the accessory piece is like an open bird beak. The length of the vaginal tube is less than 0.030 mm. These are parasites of *Blicca bjoerkna*, *Abramis brama*, and *Vimba vimba*.

D. distinguendus Nybelin, 1937 (Fig. 154)[32]

These are small worms; body can be up to 0.5 mm long and 0.12 mm wide. Length of marginal hooks is 0.015–0.028 mm. Length of anchors is 0.026–0.038 mm, main part 0.024–0.032 mm, inner root 0.005–0.010 mm, outer root 0.0025–0.005 mm, point 0.006–0.009 mm. Size of dorsal bar is 0.002–0.005 x 0.020–0.028 (first description: 0.018–0.022) mm, ventral bar 0.012–0.016 x

[32] See remarks to thesis 239.

0.017–0.022 mm. Length of copulatory organ is 0.023–0.030 mm, vaginal tube along the curve 0.025–0.030 mm.

Found on gill filaments of *Vimba vimba*, *Blicca bjoerkna*, and young *Abramis brama*; to date it has been found in not many but widely distributed localities; it seems it may be everywhere that its hosts are present.

It has been confused with other species similar to it or it has been thought to be young *D. cornu*. The data that were used here are generalized values from fish of different ages. Table 2 lists data about the chitinoid structures from fingerlings and adult fish; the copulatory organ and vaginal armament vary a little.

249 (175). The ventral bar is of another shape but is derivative from the ⊥ shape with four or five rays.

250 (274). The ventral bar has four rays and is + (or **x**) shaped.

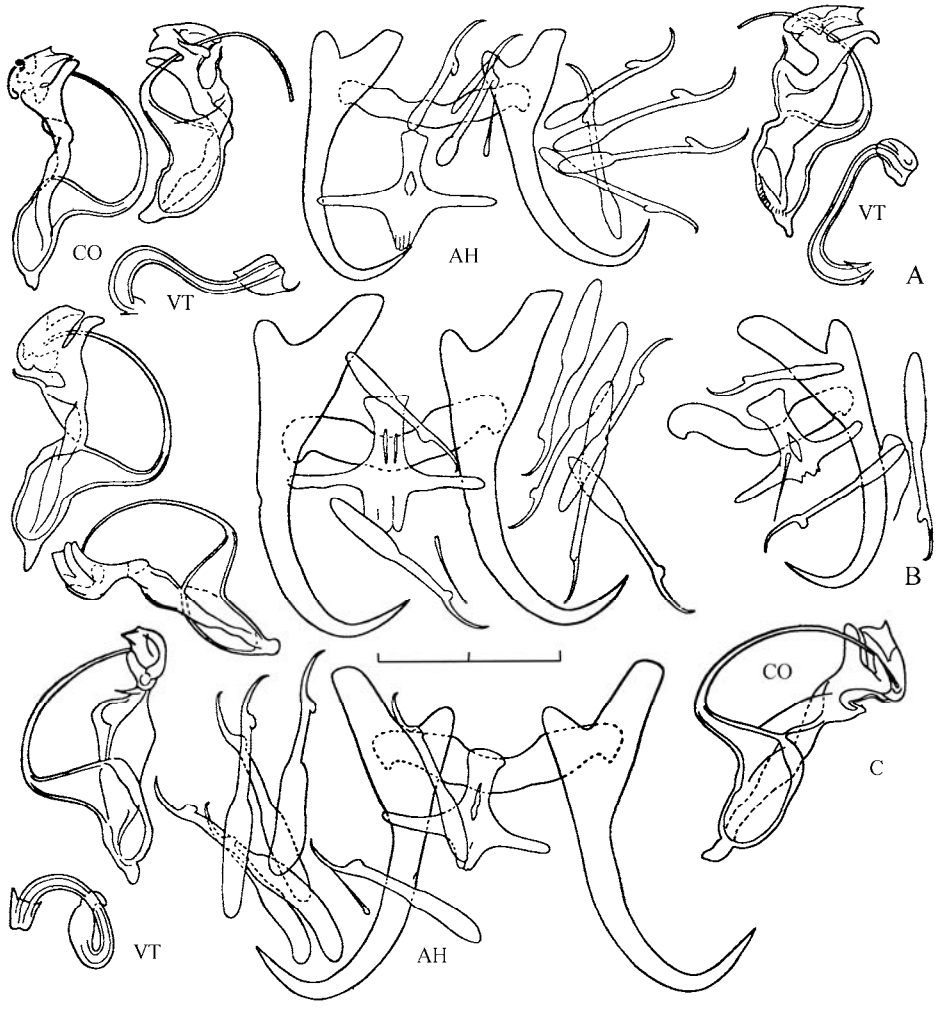
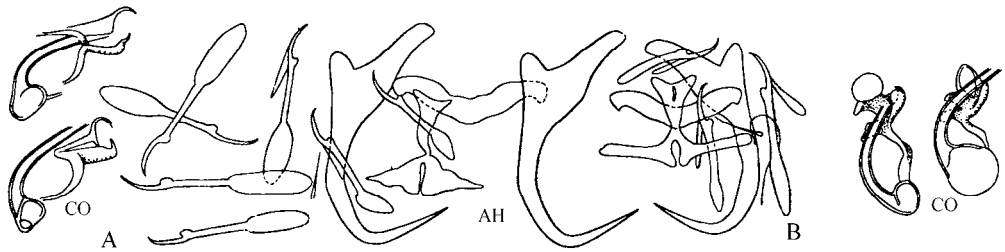
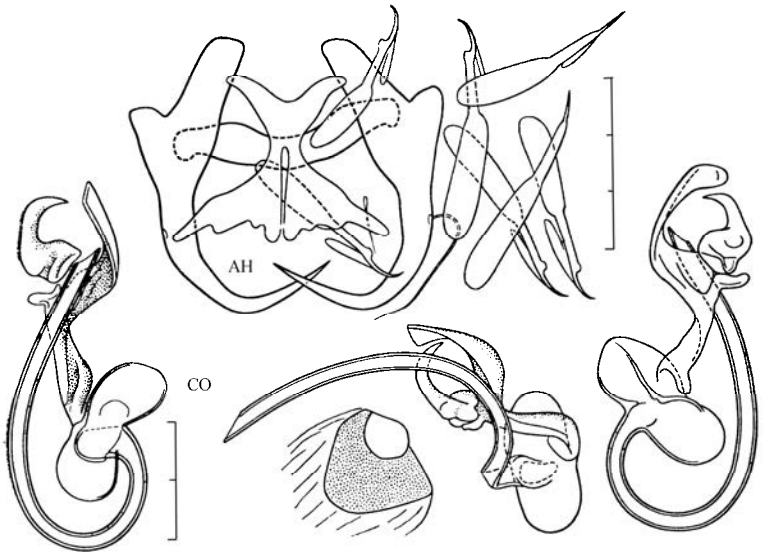


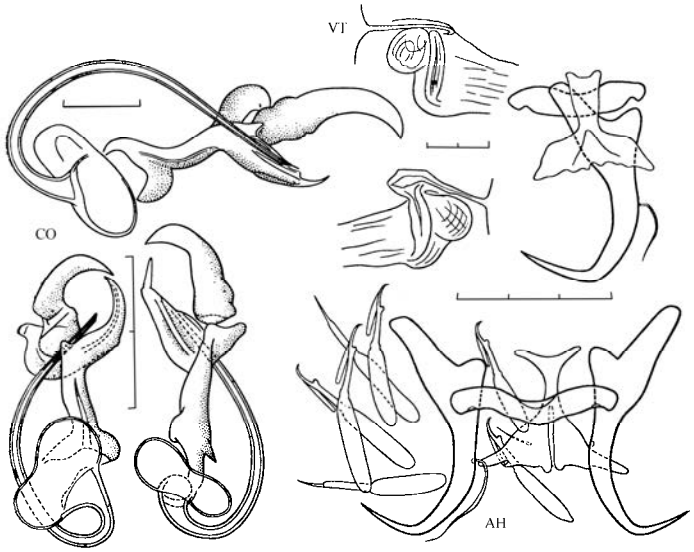
Fig. 154 - *Dactylogyrus distinguendus.*
A – from yearling of *Abramis brama* (Tisa River), B – from *Vimba vimba* (Tisa River), C – from *Blicca bjoerkna* (Volga River and Iriklinskoye Reservoir, River Ural), left copulatory organ is from feebly squeezed specimen.



155



156



157

Fig. 155 – 157.
155 - *Dactylogyrus rarissimus*: A – from Volga River (Russia), B – young fish (Lake Seliger, Russia). **156 -** *Dactylogyrus crucifer*. **157 -** *Dactylogyrus turalensis*.

Table 2. Variability in measurements of body length and haptor structures of *D. distinguendus* from fishes of different age (in mm).

Character	***Abramis brama* fingerlings**	***Blicca bjoerkna* fingerlings**	***Blicca bjoerkna* adult**	***Vimba vimba* adult**
Anchor length:				
total (dorso-apical)	0.026 – 0.031	0.026 – 0.029	0.031 – 0.037	0.031 – 0.038
main part	0.024 – 0.027	0.024 – 0.025	0.026 – 0.032	0.026 – 0.032
inner root	0.005 – 0.007	0.007	0.008 – 0.010	0.008 – 0.009
outer root	0.0025 – 0.004	0.004 – 0.005	0.003 – 0.005	0.003 – 0.004
point	0.006 – 0.008	0.007 – 0.008	0.007 – 0.009	0.007 – 0.009
Dorsal bar length	0.003 – 0.004	0.003 – 0.004	0.002 – 0.004	0.003 – 0.005
width	0.020 – 0.021	0.020 – 0.022	0.022 – 0.028	0.020 – 0.028
Ventral bar length	0.012 – 0.015	0.013 – 0.015	0.014 – 0.015	0.011 – 0.015
width	0.018 – 0.020	0.017	0.018 – 0.021	0.017 – 0.022
Marginal hooks length	0.015 – 0.022	0.015 – 0.020	0.018 – 0.028	0.016 – 0.027
Body length	0.16 – 0.20	-	0.33 – 0.48	-
Localities	Lake Seliger, Rybinskoe Reservoir	Lake Seliger, Rybinskoe Reservoir	Tisa River, Volga River Delta	Tisa River, Volga River Delta

251 (261). The ventral bar is **x** shaped; the posterior projections are triangular wing shaped. The accessory piece of the copulatory organ is claw shaped and bifurcated at the end ("crucifer" type). These are parasites of the genus *Rutilus*.

252 (253). The copulatory organ is very small (total length is less than 0.020 mm). The ventral bar is intermediate between ⊥ and **x** shaped; the anterior projection is poorly bifurcated (it is more like triangular); the posterior projections sometimes are directed not backwards but to the sides. The vaginal armament is absent. This is a parasite of young *Rutilus*; it is rarely found on adults.
D. rarissimus Gussev, 1966 (Fig. 155)
Syn.: *Dactylogyrus* sp. Bychowsky, 1936 (see Supplement cl. 2)

These are minute worms; body can be up to 0.25 mm long and 0.1 mm wide. Length of marginal hooks is 0.015–0.028 mm. Length of anchors is 0.025–0.032 mm, main part 0.022–0.025 mm, inner root 0.009–0.010 mm, outer root 0.003–0.005 mm, point 0.010–0.011 mm. Size of dorsal bar is 0.002–0.003 x 0.017–0.021 mm, ventral bar 0.010–0.014 x 0.011–0.020 mm. Length of copulatory organ is 0.016–0.020 mm.

Found on gill filaments of *Rutilus rutilus*, especially of young ones, *R. r. lacustris*; Aral Sea; rivers of the Black Sea Basin; lakes near St. Petersburg; Elbe, Volga, and Ob' Rivers and others.

253 (252). The copulatory organ is greater than 0.028 mm long. The ventral bar is butterfly shaped; it has a bifurcated anterior projection and a broad posterior one. Vaginal armament is present.

254 (255). The initial part of the copulatory tube is bubble shaped and transverse to the tube axis (like a figure **8**); the tube is relatively wide and does not narrow to the end; its diameter is greater than 0.0025 mm; the posterior end of the accessory piece is flattened and broadened into a claw "hook" that does not exceed the posterior end. The vaginal armament is in the form of a trapezium with rounded angles. Most characteristically found on *Rutilus* and its subspecies.
D. crucifer Wagener, 1857 (Fig. 156)
Syn.: *D. grislaginis* Alarotu, 1944 (?).

These are small or medium size worms; body can be up to 0.75 mm long and 0.17 mm wide. Length of marginal hooks is 0.023–0.040 mm. Length of anchors is 0.040–0.051 mm, main

part 0.030–0.039 (after Ergens and Lom (1970): 0.024–0.036) mm, inner root 0.013–0.019 mm, outer root 0.003–0.007 mm, point 0.013–0.017 mm. Size of dorsal bar is 0.004– 0.006 x 0.023–0.039 mm, ventral bar 0.020–0.029 x 0.021–0.037 mm. Total length of copulatory organ is 0.045–0.060 (up to 0.072) mm; its tube is nearly cylindrical; its length along the curve is 0.070–0.092 mm. Size of the poorly visible vaginal armament is 0.018 x 0.018 mm.

Found on gill filaments of *Rutilus rutilus*, *R. r. aralensis*, *R. r. heckelii*, *R. r. lacustris*, and *R. caspicus*; found everywhere in the area of its hosts, including Great Britain and France. Data on finds of *D. crucifer* on gills of other fishes are doubtful.

Variability of the copulatory organ of *D. crucifer* has been noted, especially the diameter of the tube and the ratio of the accessory piece ends.

The **8**-shaped initial part of the copulatory tube is not easily visible in all specimens of typical *D. crucifer*. In some cases it looks bubble shaped, as in *D. erhardovae*. The "claw" of the accessory piece, its disposition against the tube end, and the length of the proximal end of the accessory piece are highly variable; this was noted by Lopukhina (personal communication). These issues make identification of *D. crucifer* and other similar species rather difficult; perhaps they are hybrids of these species (e.g., *D. crucifer* and *D. caballeroi*) or they may be separate species, such as *D. turaliensis*. More material and analyses are necessary to solve these problems.

255 (256). The initial part of the copulatory tube is figure **8** shaped, but the tube is relatively narrow and converges to the end; its diameter is about 0.0015 mm. The posterior end of the accessory piece is narrow, and the claw "hook" exceeds the posterior end. The vaginal armament is a **Γ**- or **T** – shaped structure.

D. turaliensis Aligadzhiev, Gussev et Kazieva, 1984 (Fig. 157, 158)

These are small worms; body can be up to 0.6 mm long and 0.13 mm wide. Length of marginal hooks is 0.024–0.037 mm. Length of anchors is 0.035–0.043 mm, main part 0.027–0.033 mm, inner root 0.012–0.015 mm, outer root 0.0035–0.0040 mm, point 0.011–0.014 mm. Size of dorsal bar is 0.0035–0.005 x 0.027–0.032 mm, ventral bar 0.017–0.024 x 0.015–0.025 mm. Length of copulatory organ is 0.037–0.043 mm, tube along the curve 0.045–0.057 mm. The posterior end of the accessory piece is pointed (in *D. crucifer* it is flattened and broadened); a massive "hook" lies over it. In *D. crucifer* it is vice versa (the posterior end is over the "hook").

Found only on *Rutilus caspicus*; water bodies of Kazakhstan and Central Asia, rivers of the Caspian Sea Basin; its area seems to be limited to the Caspian and Aral Seas Basins.

256 (254). The initial part of the copulatory tube is in the form of a rounded widening; the tube is rather narrow; its diameter in the middle is less than 0.0015 mm. The vaginal armament has another shape.

257 (260). The initial part of the copulatory tube lacks a projection.

258 (259). The end claw of the short but rather massive accessory piece is very massive and has an additional projection at the base of the claw "hook". The vaginal armament is shaped like a bent tube with a bubble-shaped structure at each end. These are parasites of *Rutilus frisii kutum*.

D. frisii Bychowsky, 1933 (Fig. 159)

These are small or medium size worms; body length is up to 0.7 mm, width 0.12 mm. Length of marginal hooks is 0.024–0.034 mm. Length of anchors is 0.041–0.048 mm, main part 0.028–0.038 mm, inner root 0.012–0.016 mm, outer root 0.004–0.006 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.004–0.005 x 0.022–0.034 mm, ventral bar 0.013 (?)–0.021 x 0.020–0.030 mm. Length of copulatory organ is 0.040–0.045 mm. The vaginal tube is **V** shaped and 0.020–0.026 mm long (without bubbles at the ends).

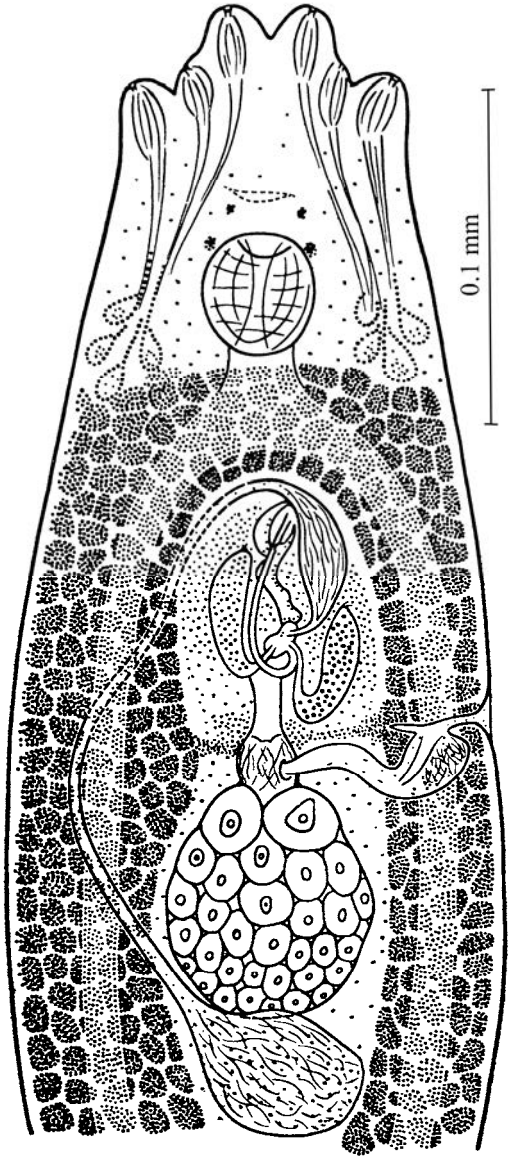
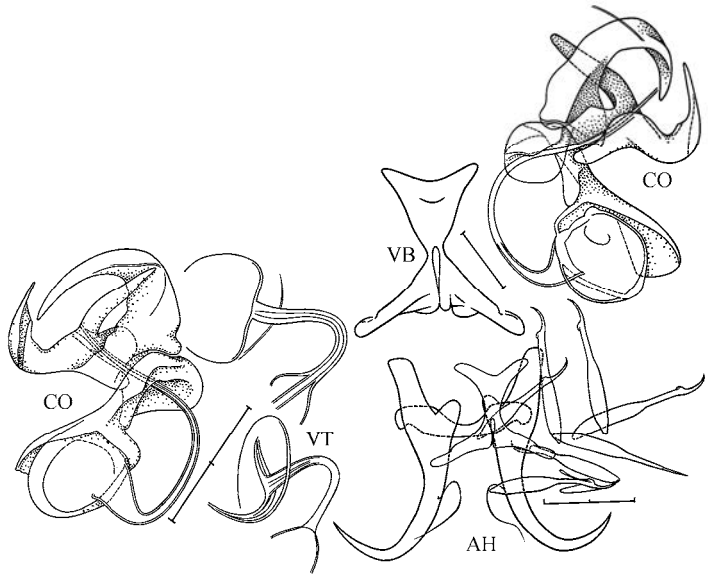
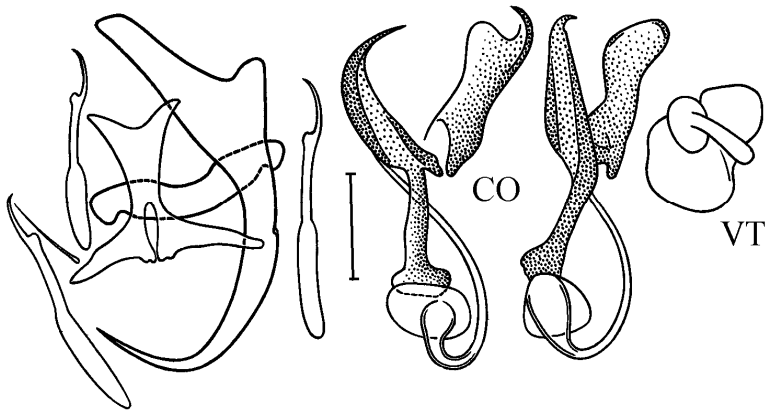


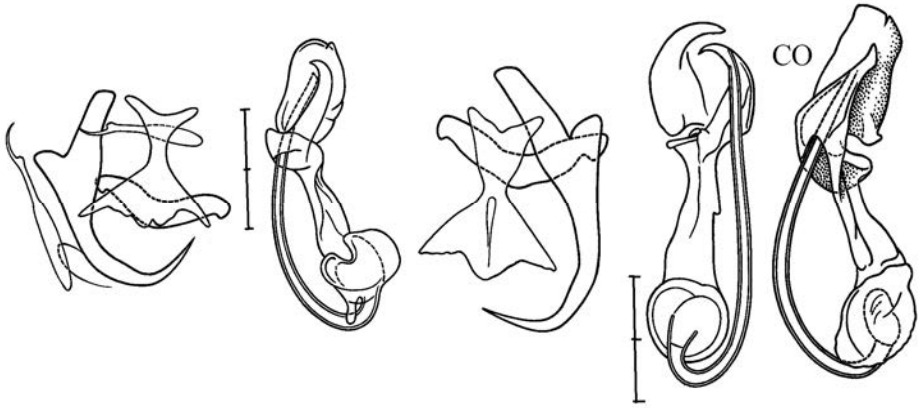
Fig. 158 - Scheme of *Dactylogyrus turalensis* morphological structure made up on basis of alive worms roughs (dorsal view).



159



160



161

Fig. 159 – 161.
159 - *Dactylogyrus frisii.* **160 -** *Dactylogyrus erhardovae* from *Rutilus rubilio* (Lake Skadar). **161 -** *Dactylogyrus* sp. *(caballeroi* ?).

Found on gill filaments of ***Rutilus frisii kutum***; Caspian Sea Basin; finds in the basin of the Black Sea seem to be doubtful. Data on occurrence on gills of ***Rutilus frisii*** seems to be an error; it may have been confused with ***D. nybelini***.

259 (258). The claw is thin and lacks an additional projection at the base of the claw "hook". The vaginal armament is in the form of a rounded structure with a short tube. This is a parasite of ***Rutilus***.

D. erhardovae Ergens, 1970 (Fig. 160)

These worms are minute; body can be up to 0.3 mm long and 0.06 mm wide. Length of marginal hooks is 0.016–0.026 mm. Length of anchors is 0.028–0.035 mm, main part 0.023–0.028 mm, inner root 0.010–0.012 mm, outer root about 0.003 mm, point 0.007–0.009 mm. Size of dorsal bar is 0.003–0.004 x 0.017–0.020 mm, ventral bar 0.015–0.016 x 0.016–0.020 mm. Length of copulatory organ is 0.029–0.036 mm, vaginal armament 0.010 x 0.015 mm.

Found on gill filaments of ***Rutilus rubilio*** and ***R. rutilus lacustris***; Lake Skadar (former Yugoslavia) and Ob' River (Russia); surely will be found on gills of roach from the Tisa River (Ukraine) and other water bodies.

In different regions of Russia (and in East Germany, personal communication of H. J. Glaeser) a form very similar to ***D. caballeroi*** has been found on roach; this form differs from the typical form by the absence of a projection on the initial part of the copulatory tube and by having a less massive copulatory organ (Fig.161). Glaeser et Gussev thought this form to be a young specimen of ***D. caballeroi***. ***D. erhardovae*** was described a little later and is similar to that form. However, the form found by Glaeser et Gussev lacks the vaginal armament (in ***D. erhardovae*** it is poorly visible) and all other chitinoid structures, especially the copulatory organ, were larger and more massive than in ***D. erhardovae*** (Fig.161).

260 (257). The initial part of the copulatory organ has a short but massive supporting projection.

D. caballeroi Prost, 1960 (Fig. 162)

These are small or medium size worms; body can be up to 0.75 mm long and 0.12 mm wide. Length of marginal hooks is 0.022–0.037 mm. Length of anchors is 0.044–0.050 mm, main part 0.036–0.040 mm, inner root 0.014–0.017 mm, outer root 0.004–0.006 mm, point 0.015–0.019 mm. Size of dorsal bar is 0.005–0.007 x 0.028–0.033 mm, ventral bar 0.024–0.030 x 0.021 (?)–0.033 mm. Total length of copulatory organ with projection is 0.078–0.084 mm. Vaginal armament is about 0.020 x 0.020 mm with a short tube of 0.010 mm length.

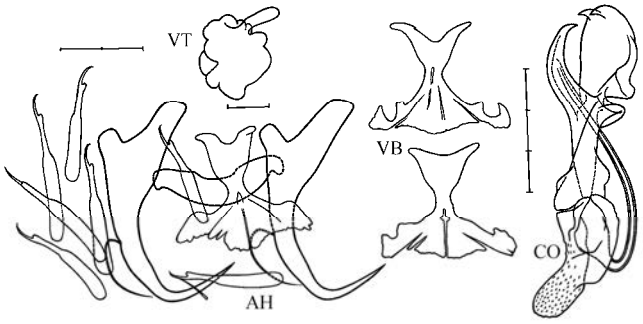
Found on gill filaments of ***Rutilus rutilus***; Vistula River, Iriklinskoye Reservoir (Ural River). Lake Seliger (Volga River Basin); surely its distribution is wider.

261 (251). The dorsal bar is + shaped; the anterior projection is not bifurcated; the posterior projection may or may not be bifurcated. The copulatory organ is of different types.[33]

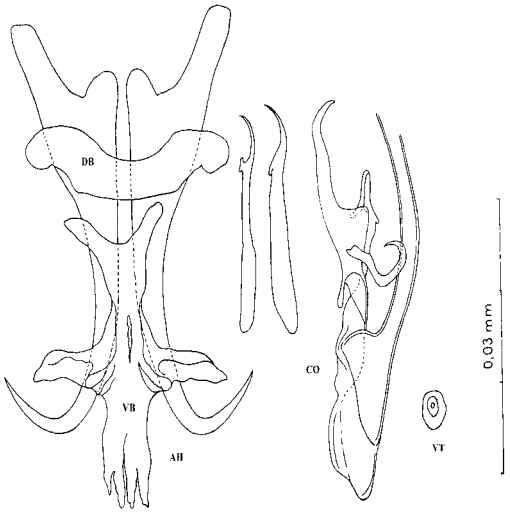
262 (269). The broad posterior projection of the ventral bar has a fringe or is split into four short rays at the end, but it is not bifurcated.

263 (266). The anterior projection of the ventral bar is bifurcated.

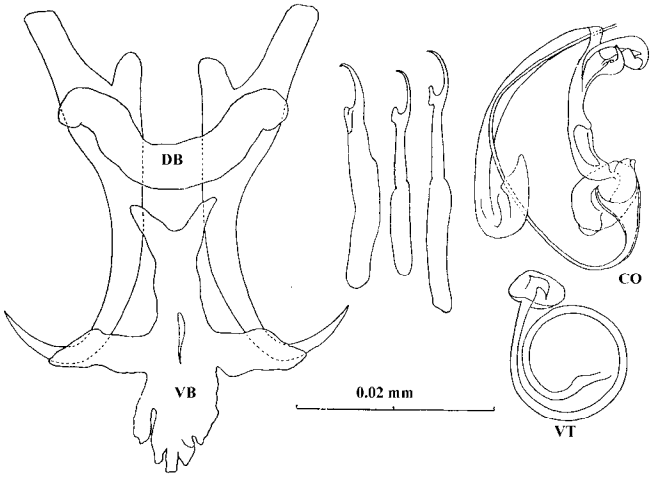
[33] See also theses 92, 135, 190, 204, 246 and associated figures.



162



163



164

Fig. 162 – 164.
162 - *Dactylogyrus caballeroi*. **163 -** *Dactylogyrus martinovici* (after Ergens, 1970). **164 -** *Dactylogyrus petkovici* (after Ergens, 1970).

264 (265). The posterior projection of the ventral bar is split into four short rays at the end. The copulatory organ is transitional between the "nanus" and "chondrostomi" types and is similar to the "folkmanovae" type. The copulatory tube is short, wide, and slightly curved.

D. martinovici Ergens, 1970 (Fig. 163)

Length of marginal hooks of various forms is 0.022–0.027 mm. Total length of anchors is 0.043–0.048 (at the average 0.044) mm, main part 0.036–0.039 (0.036) mm, outer root 0.004–0.006 (0.005) mm, inner root 0.012–0.013 (0.013) mm, point 0.010 mm. Size of dorsal bar is 0.005–0.006 x 0.028–0.030 (0.005 x 0.029) mm, ventral bar 0.032–0.035 (0.033) x 0.028–0.030 (0.028) mm. Length of copulatory organ is about 0.044 mm. Vaginal armament is 0.004–0.005 mm in diameter.

Found on gills of ***Pachychilon pictum***; Lake Skadar, former Yugoslavia.

265 (264). The posterior projection of the ventral bar has a fringe at the end. The copulatory organ is of the "nybelini" type.

D. petkovici Ergens, 1970 (Fig. 164)

Length of marginal hooks is 0.020–0.027 mm. Total length of anchors is 0.035–0.038 (average 0.036) mm, main part 0.026–0.030 (0.027) mm, outer root 0.003–0.005 (0.004) mm, inner root 0.010–0.012 (0.010) mm, point 0.007–0.009 (0.008) mm. Size of dorsal bar is 0.004–0.005 x 0.024–0.026 (0.004 x 0.024)mm, ventral bar 0.027–0.030 (0.027) x 0.026–0.030 (0.026) mm. Total length of copulatory organ is 0.024–0.029 (0.025) mm. Length of vaginal armament is 0.050 mm.

Found on gills of ***Pachychilon pictum***; Lake Skadar, former Yugoslavia.

266 (263). The anterior projection of the ventral bar is not bifurcated.

267 (268). The posterior projection of the ventral bar is broader than the anterior projection, the end of which is rounded. The copulatory organ is ring shaped (of the "chondrostomi" type). The vaginal armament is a long tube with a folded extension. These are parasites of *Alburnus* and *Alburnoides*.

D. tissensis Zachvatkin 1951 (Fig. 165)

These are minute worms; body length can be up to 0.3 mm, width 0.09 mm. Length of marginal hooks is 0.025–0.037 mm. Length of anchors is 0.037–0.046 mm, main part 0.030–0.038 mm, inner root 0.008–0.010 mm, outer root 0.004–0.005 mm, point 0.010 mm. Size of dorsal bar is 0.004–0.006 x 0.029–0.033 (after Zachvatkin (1951): 0.026) mm; ventral bar 0.040 x 0.030 mm. Total length of copulatory organ is 0.038–0.050 mm, vaginal tube along the curve with folded extension 0.055–0.065 mm.

Found on gill filaments of ***Alburnus alburnus*** and ***Alburnoides bipunctatus***; Tisa River (Ukraine).

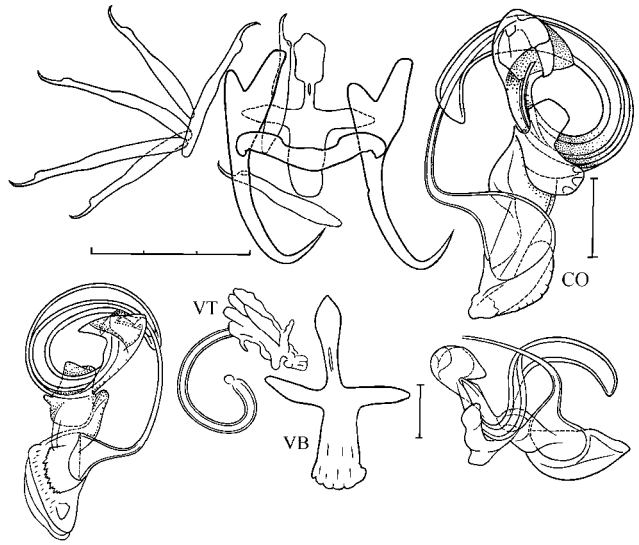
268 (267). The posterior projection of the ventral bar is not broader than the anterior projection, which is straight truncated or has a dent in the middle. The copulatory organ is of the "linstowi" type. The vaginal armament looks like a small mushroom. These are parasites of the genera ***Barbus*** and ***Luciobarbus***.

D. goktschaicus Gussev, 1966 (Fig. 166)

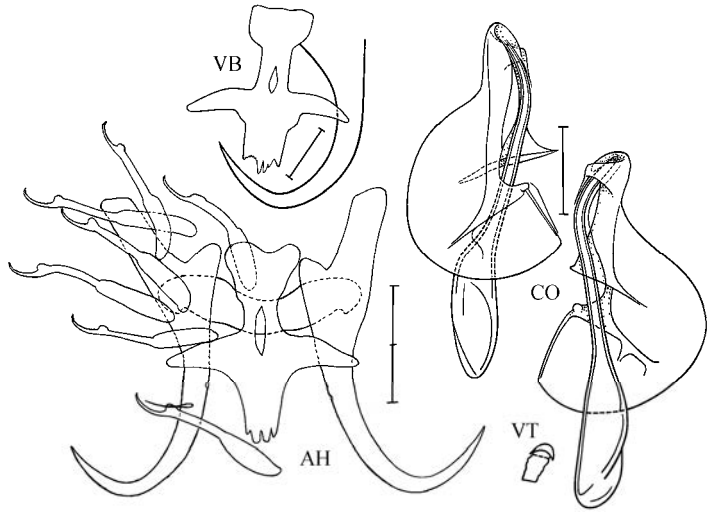
These are minute worms; body length can be up to 0.32 mm, width 0.08 mm. Length of marginal hooks is 0.023–0.030 mm. Length of anchors is 0.044–0.054 mm, main part 0.037–0.039 mm, inner root 0.015–0.016 mm, outer root 0.005–0.006 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.005–0.006 x 0.031–0.036 mm, ventral bar 0.029–0.035 x 0.027–0.037 mm. Length of copulatory organ is 0.039–0.042 mm, length of vaginal "mushroom" about 0.005 mm.

Found on gill filaments of ***Barbus goktschaicus***, ***B. lacerta cyri***, ***B. tauricus***, ***B. kubanicus***, ***B. mursa***, and ***Luciobarbus capito***; Kuban' River; rivers of Crimea and Transcaucasus.

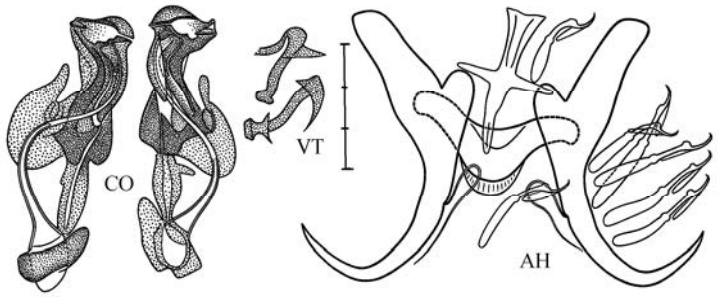
269 (262). The posterior projection of the ventral bar is more or less bifurcated and relatively narrow.



165



166

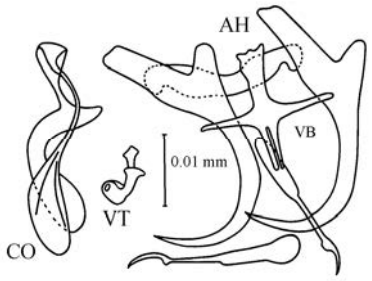


167

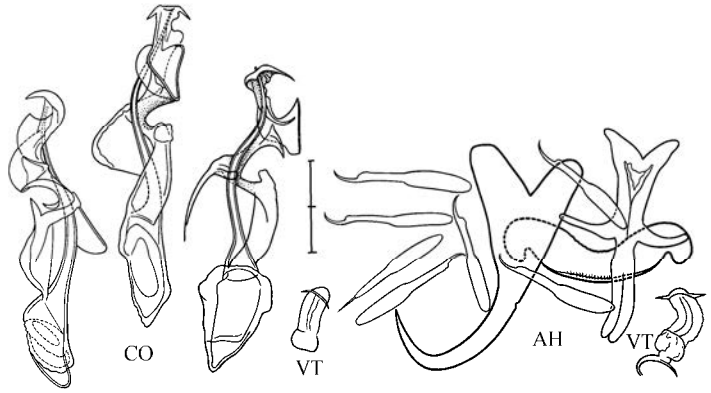
Fig. 165 – 167.

165 - *Dactylogyrus tissensis.* **166 -** *Dactylogyrus goktschaicus* (after Gussev, 1966a). **167 -** *Dactylogyrus akaraicus.*

168



169



170

Fig. 168 – 170.
168 - *Dactylogyrus chramulii*. **169 -** *Dactylogyrus gracilis* (after Mikailov, 1974). **170 -** *Dactylogyrus carpathicus.*

270 (273). All chitinoid structures are large. The length of the anchors and copulatory organ is greater than 0.050 mm. These are parasites of the genera *Barbus* and *Capoeta*.

271 (272). The longest marginal hooks are almost twice as short as the anchors. The initial part of the copulatory tube is rounded or slightly elongated and rather thin. These are parasites of the genus *Barbus*.

D. akaraikus Mikailov, 1974 (Fig. 167)

These are small worms; body length can be up to 0.45 mm, width 0.15 mm. Length of marginal hooks is 0.023–0.036 mm. Length of anchors is 0.058–0.065 mm, main part 0.043–0.050 mm, inner root 0.019–0.023 mm, outer root 0.004–0.006 mm, point 0.016–0.019 mm. Size of dorsal bar is 0.008–0.012 (without posterior limbus at the middle part) x 0.037–0.042 mm, ventral bar 0.024–0.028 x 0.035–0.041 mm. Length of copulatory organ is 0.060–0.070 (first description: 0.057–0.058) mm. Length of vaginal tube is 0.020–0.021 mm.

Found on gill filaments of *Barbus lacerta cyri* and *B. mursa*; basin of the Araks River (Armenia).

D. gracilis Mikailov, 1974 is very similar to it. See thesis 273 (270).

272 (271). The longest marginal hooks are 1.5 times as short as the anchors. The initial part of the copulatory tube is very long and massive. These are parasites of *Capoeta*.

D. chramulii Kojava, 1966 (Fig. 168)

These are large (?) or medium size worms; body length can be up to 1.2 (?) mm, width 0.15 mm. Length of marginal hooks is 0.030–0.041 mm. Length of anchors is 0.050–0.060 (first description: 0.048–0.050) mm, main part 0.040–0.043 mm, inner root 0.021–0.025 mm, outer root 0.006–0.009 mm, point 0.015–0.019 mm. Size of dorsal bar is 0.005–0.006 x 0.041–0.045 mm, ventral bar 0.032–0.036 x 0.030–0.032 mm. Total length of copulatory organ is 0.053–0.060 mm, vaginal tube about 0.010 mm.

Found on gill filaments of *Capoeta capoeta*, *C. c. sevangi*, and *C. c. gracilis*; water bodies of East Transcaucasus.

273 (270). All chitinoid structures are rather small; the length of the anchors and copulatory organ is less than 0.040 mm.

D. gracilis Mikailov, 1974 (Fig. 169)

Body length is 0.360 mm and width 0.090 mm. Length of marginal hooks is 0.023–0.038 (after Mikailov, 1974: 0.018–0.021) mm. Length of pair V of marginal hooks is nearly equal to the total length of the anchors and is 1.5 times the length of the II pair of marginal hooks. Total length of anchors is 0.036–0.038 (0.029–0.030) mm, main part 0.025–0.027 (0.022–0.024) mm, outer root 0.004 (0.003–0.004) mm, inner root 0.013 (0.010–0.011) mm, point 0.012–0.013 (0.011) mm. Size of dorsal bar is 0.002 x 0.025–0.028 (0.003 x 0.023) mm, ventral bar 0.020–0.022 x 0.018–0.021 (0.017–0.018 x 0.017–0.018) mm. Total length of copulatory organ is 0.029–0.034 (0.025–0.026) mm, tube 0.034–0.036 mm long and 0.001 mm wide, the initial part 0.015 x 0.006 mm. Length of accessory piece is 0.029 mm. Vaginal armament (in form of tube) is 0.007–0.008 mm long and 0.002–0.003 mm wide.

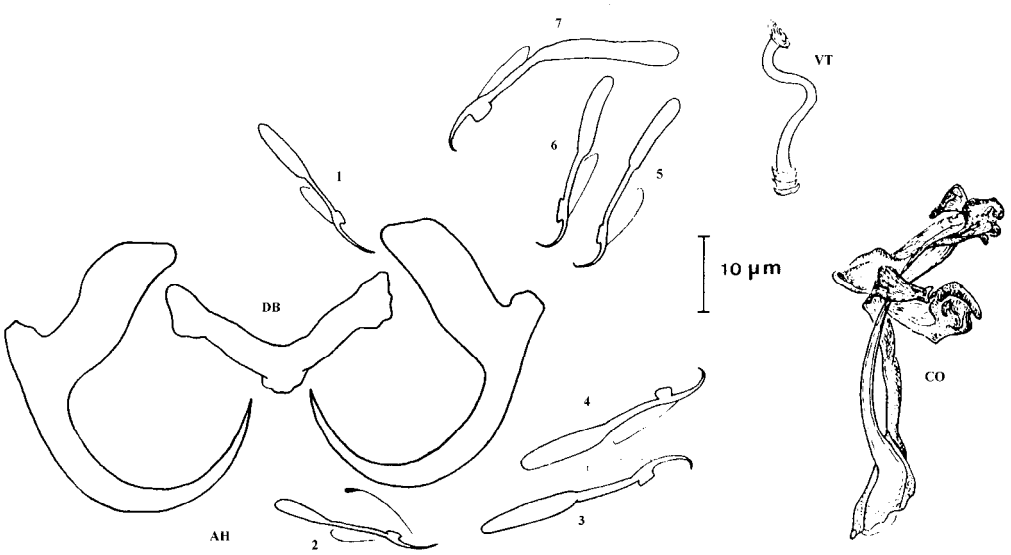
Found on skin and gills of *Capoeta capoeta*, *C. c. sevangi*, *C. c. gracilis*, *Squalius cephalus*, and *Barbus lacerta cyri*; Rioni and Mtkvari (Kura) Rivers, the suburbs of the Tbilisi and Kutaisi cities (Georgia); Araks and Talysh Rivers (Armenia).

274 (250). The ventral bar is derived from the + shaped, five radial ("barbus" type) type, with more or less bifurcated anterior projection, branches of that are widely spaced; posterior projection is split. The copulatory organ is of the “carpathicus”, “linstowi”, “kulwieci” or “chondrostomi” type or is derived from the last type. The ventral bar is absent in the haptor, which is of the “sphyrna” type.

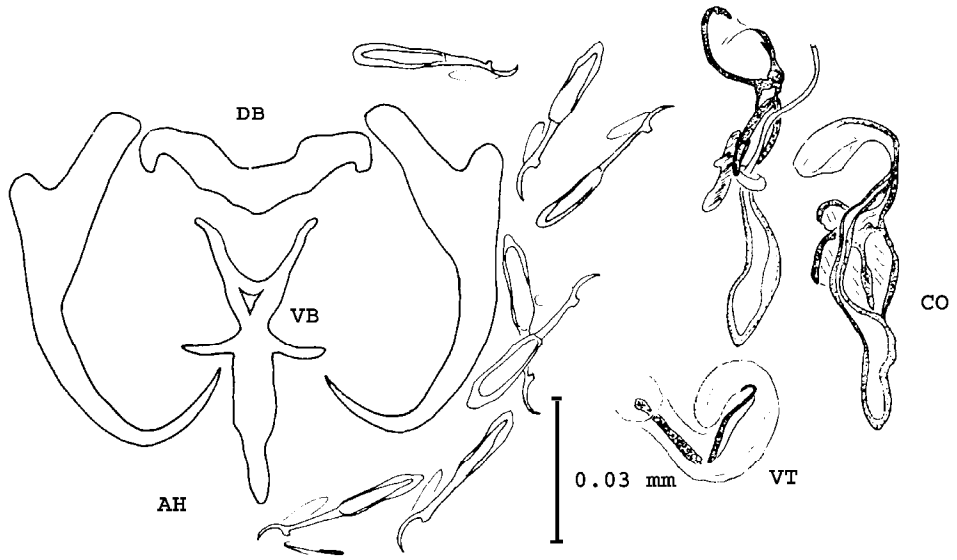
275 (278). The copulatory organ is of the “carpathicus” type; the initial part of the copulatory tube is expanded; the tube has thick walls and is curved like an **S**. The accessory piece consists of two successive curved alar plates.

276 (277). The anchors have nearly equally sized roots (the inner one is slightly longer than the outer one).

D. carpathicus Zachvatkin, 1951 (Fig. 170)



171



172

Fig. 171 – 172.

171 - *Dactylogyrus legionensis* (after Gonzalez-Lanza et Alvarez-Pellitero, 1982). **172 -** *Dactylogyrus crivellius* (after Dupont et Lambert, 1987).

These are small or medium size worms; body can be up to 0.8 mm long and 0.16 mm wide. Length of marginal hooks is 0.026–0.030 mm. Length of anchors is 0.048–059 mm (dorso-apical and ventro-apical length are nearly equal or the latter is slightly longer), main part 0.042–0.046 mm,

inner root 0.011–0.015 mm, outer root 0.010–0.012 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.006–0.008 x 0.035–0.043 mm, ventral bar 0.033–0.048 x 0.024–0.033 mm. Length of copulatory organ is 0.060–0.071 mm. Vaginal tube is short and broad; its length is 0.010–0.019 mm, diameter 0.004–0.007 mm.

Found on gill filaments of *Barbus barbus*, *B. tauricus*, *B. peteneyi*, and *B. kubanicus*; Danube River; rivers of Crimea; Kuban River; southern France.

277 (278). The anchors as a result attachment manner on gills are of the “sphyrna” type. The ventral bar is absent.

D. legionensis Gonzalez-Lanza et Alvarez-Pellitero, 1982 (Fig. 171)

Body length is 0.470–1.030 (average 0.752) mm, width 0.115–0.220 (0.164) mm. Pharynx is 0.035–0.060 (0.043) x 0.030–0.060 (0.041) mm. Marginal hooks of the III pair are larger than the others, 0.032–0.041 (0.038) mm long, with handle 0.016–0.025 (0.021); length of I and II pairs of marginal hooks 0.021–0.028 (0.025) mm, handle 0.007–0.014 (0.011) mm and 0.020–0.027 (0.024) mm, handle 0.007–0.012 (0.009) mm, respectively. The rest of the marginal hooks are similar in size: IV: 0.027–0.035 (0.032) mm, handle 0.012–0.017 (0.016) mm; V: 0.026–0.032 (0.029) mm, handle 0.012–0.017 (0.014) mm; VI: 0.026–0.033 (0.030) mm, handle 0.010–0.017 (0.014) mm; VII: 0.025–0.031 (0.027) mm, handle 0.009–0.016 (0.012) mm. Length of anchors is 0.038–0.045 (0.041) mm, outer root 0.003–0.005 (0.004) mm, inner root 0.019–0.025 (0.021) mm long and 0.007–0.011 mm wide, main part 0.020–0.034 (0.031) mm, point 0.018–0.025 (0.021) mm. Size of dorsal bar is 0.003–0.007 (0.005) x 0.027–0.038 (0.032) mm; it is V-shaped with a slightly widened end. Length of copulatory organ is 0.053–0.068 (0.062) mm; the tube is 0.049–0.060 (0.056) mm long and 0.001–0.003 (0.002) mm wide in the middle part; the initial part, which is widened, is 0.012–0.018 (0.015) mm long. The vaginal tube is 0.024–0.033 (0.028) mm long along the curve and 0.002–0.005 (0.003) mm wide. Size of eggs is 0.068–0.083 (0.074) x 0.050–0.070 (0.061) mm. According to El-Gharbi et al. (1992) the length of the copulatory organ is 0.054 (0.049–0.059) mm, tube 0.051 (0.048–0.055) mm, vaginal tube 0.025 (0.021–0.029) mm.

Found on gills of *Luciobarbus bocagei, L. guiraonis,* and *L. graellsii*; Spain.

278 (279). The initial part of the copulatory tube is massive and very gaunt. The posterior part of the accessory piece is expanded like a spoon. The copulatory organ is of the “linstowi” type. The posterior projection of the ventral bar lacks well-defined bifurcation. These are parasite of the genus *Barbus*.

D. crivellius Dupont et Lambert, 1987 (Fig. 172)

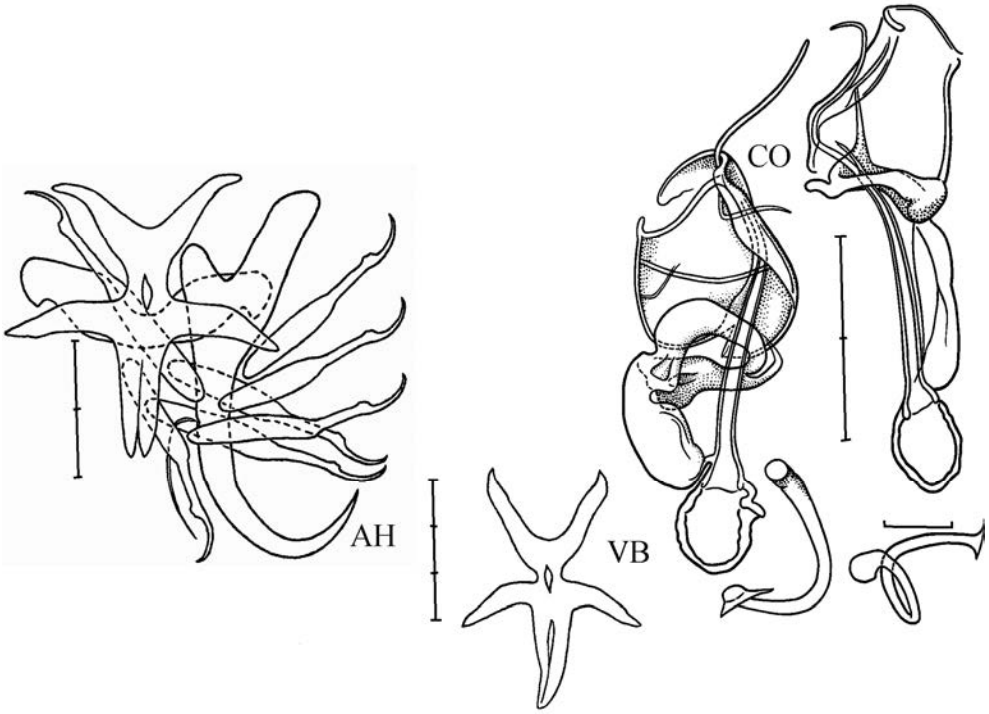
Length of marginal hooks: I and II: 0.032 mm, the rest 0.031–0.034 mm. Total length of anchors is 0.058–0.061 mm, main part 0.049–0.052 mm, outer root 0.007–0.008 mm, inner root 0.019–0.020 mm, point 0.017–0.018 mm. Size of dorsal bar is 0.009 x 0.042–0.043 mm, ventral bar 0.026 x 0.042 mm. Length of copulatory organ is 0.058–0.062 mm. Vaginal armament is **V** shaped.

Found on gills of *Barbus prespensis*; Lake Mikri Prespa (Greece).

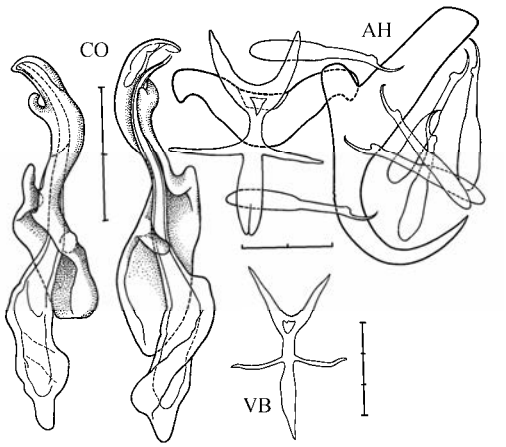
279 (291). The initial part of the copulatory tube is massive with thick walls; the accessory piece is like a massive long shield lying along the tube; its proximal part is widened and has short finger-like or claw-shaped projections (of the "kulwieci" type). These are parasites of the genera *Barbus* and *Luciobarbus*.

280 (281). The distal end of the accessory piece is barrel shaped and has thin walls.

D. jamansajensis Osmanov, 1958 (Fig. 173)



173



174

Fig. 173 – 174.
173 - *Dactylogyrus jamansajensis*. **174 -** *Dactylogyrus scrjabinensis.*

These are medium size worms; body can be up to 0.8 mm long and 0.11 mm wide. Length of marginal hooks is 0.028–0.034 mm. Length of anchors is 0.048–0.059 mm, main part 0.041–0.048 mm, inner root 0.018–0.022 mm, outer root 0.007–0.008 mm, point 0.011–0.013 mm. Size of dorsal bar is 0.005–0.006 x 0.037–0.042 (in first description 0.010 x 0.045) mm, ventral bar 0.042–0.054 x 0.038–0.040 mm. Total length of copulatory organ is 0.048–0.058 (0.040–0.048) mm. Length of curved vaginal tube is 0.025–0.040 mm.

Found on gill filaments of *Luciobarbus capito conocephalus* and *Barbus lacerta cyri*; water bodies of Central Asia, Kazakhstan, and East Transcaucasus.

281 (280). The distal end of the accessory piece has another form.

282 (290). The total length of the anchors is greater than 0.041 mm.

283 (284). The vaginal armament is absent. The total length of the copulatory organ is 0.055–0.063 mm.
D. scrjabinensis Osmanov, 1958 (Fig. 174)

These are small or medium size worms; body length can be up to 0.7 mm, width 0.13 mm. Length of marginal hooks is 0.030–0.036 mm. Length of anchors is 0.050–0.062 mm, main part 0.038–0.043 (first description 0.025–0.032) mm, inner root 0.025–0.032 mm, outer root 0.006–0.009 mm, point 0.018–0.021 (0.016–0.019) mm. Size of dorsal bar is 0.010–0.012 x 0.038–0.041 mm, ventral bar 0.048–0.054 x 0.030–0.036 mm. Length of copulatory organ is 0.055–0.063 (0.051–0.071) mm. Vaginal armament is a slightly bent tube (Osmanov, 1958). It was not found on slides from the collection of Zoological Institute RAS.

Found on gill filaments of *Luciobarbus brachycephalus*; water bodies of Central Asia.

284 (283). The vaginal armament is present. The total length of the copulatory organ varies within ranges either 0.075–0.085 or 0.032–0.052 mm.

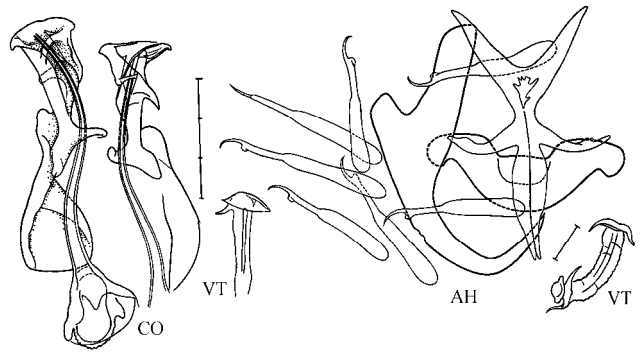
285 (286). The total length of the copulatory organ is 0.075–0.085 mm.
D. kulwieci Bychowsky, 1931 (Fig. 175)

These are medium size or large worms; body length can be up to 0.9 mm, width 0.21 mm. Length of marginal hooks is 0.033–0.045 mm. Length of anchors is 0.060–0.070 mm, main part 0.045–0.053 mm, inner root 0.023–0.030 mm, outer root 0.008–0.009 mm, point 0.020–0.023 mm. Size of dorsal bar is 0.010–0.014 x 0.050–0.055 mm, ventral bar 0.056–0.065 x 0.035–0.043 mm. Length of copulatory organ is 0.075–0.085 mm, broad vaginal tube 0.026–0.030 with diameter 0.004–0.005 mm.

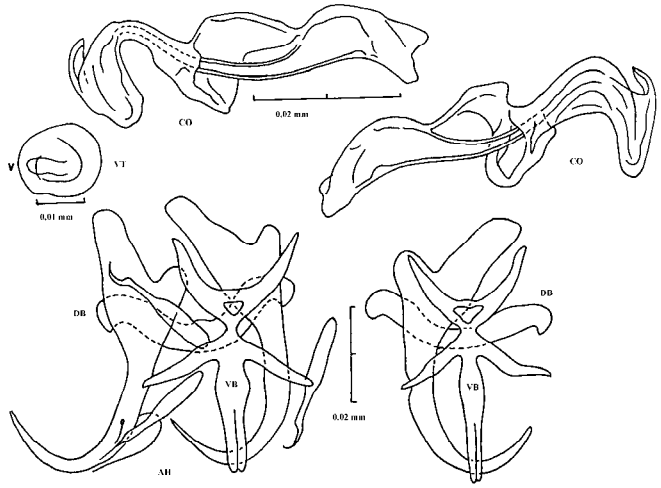
Found on gill filaments of *Luciobarbus capito*, *L. c. conocephalus*, *L. brachycephalus*, *L. b. caspius*, and *Barbus lacerta cyri*; water bodies of Central Asia, Kazakhstan, East Transcaucasus. Subspecies *D. kulwieci galilensis* Paperna, 1961 was described from Israel on the gills of *B. longiceps*. It seems that it is another species. Paperna (1961) thought *D. kulwieci* to be a synonym of *D. affinis*, but that is incorrect. These two species differ from one another, especially in the structure of the copulatory organ.

286 (287). The total length of the copulatory organ is 0.050–0.052 mm. The vaginal armament consists of a round plate with a short tube 0.007 mm long.
D. inutilis Bychowsky, 1949 (Fig. 176)

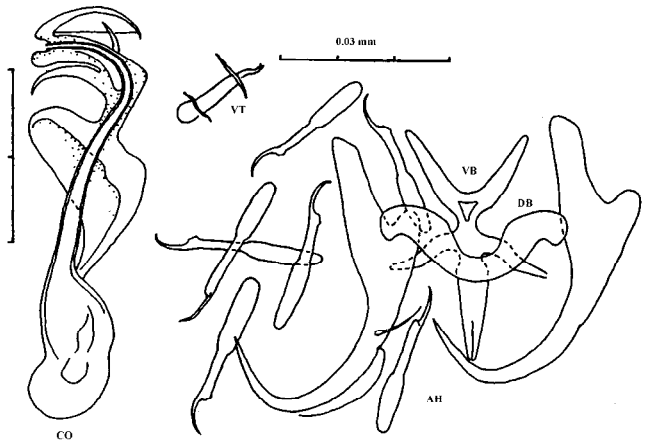
Body can be up to 0.800 mm long and 0.130 mm wide. Length of marginal hooks is 0.026–0.033 mm. Length of anchors is 0.055–0.063 mm, main part 043–0.049 mm, inner root 0.017–0.021 mm, (measurements of outer root is absent), point 0.015–0.019 mm.



175



176



177

Fig. 175 – 177.
175 - *Dactylogyrus kulwieci*. **176 -** *Dactylogyrus inutilis* (after Gussev et al., 1993a). **177 -** *Dactylogyrus kersini* (after Gussev et al., 1993c).

Size of dorsal bar is 0.005–0.006 x 0.040–0.044 mm, ventral bar 0.045–0.050 x 0.032–0.038 mm. Total length of copulatory organ is 0.050–0.052 mm; initial part of the tube 0.018–0.019 x 0.007 mm.

Found on *Luciobarbus xanthopterus*; Tigris River, near Baiji, Iran.

287 (288). The total length of the copulatory organ is 0.046 mm. The vaginal armament is in the form of a short tube crossed by two bars, 0.018 x 0.005 mm in size.

D. kersini Gussev, Jalali et Molnar, 1993 (Fig. 177)

These small worms can be up to 0.5 mm long and 0.12 mm wide. Total length of marginal hooks is 0.025–0.028 mm. Length of anchors is 0.047–0.049 mm, main part 0.035–0.037 mm, inner root 0.016–0.017 mm, outer root 0.005–0.006 mm, point 0.012–0.014 mm. Size of dorsal bar is 0.0035–0.004 x 0.033 mm, ventral bar 0.043–0.047 x 0.030–0.032 mm. Length of copulatory organ is 0.046 mm, diameter of tube 0.0015 mm, initial part 0.017 x 0.008 mm.

Found on *Barbus kersin*; Dez River, water system of the Tigris River, Iran.

288 (289). The total length of the copulatory organ is 0.035–0.038 mm. The vaginal armament is in the form of a mushroom-like tube, 0.010–0.013 x 0.004–0.005 mm in size.

D. deziensis Gussev, Jalali et Molnar, 1993 (Fig. 178)

These are small worms; body length is 0.5 mm, width 0.12 mm. Total length of marginal hooks is 0.025–0.028 mm. Length of anchors is 0.042–0.048 mm, main part 0.035–0.038 mm, inner root 0.016–0.017 mm, outer root 0.004–0.007 mm, point 0.011–0.013 mm. Size of dorsal bar is 0.0030–0.0035 x 0.034–0.035 mm, ventral bar 0.023 x 0.030–0.035 mm. Length of copulatory organ is 0.035–0.038 mm, diameter of tube 0.002 mm in the middle and 0.012–0.013 x 0.007–0.010 mm at the initial part.

Found on *Barbus kersin*; Dez River, water system of the Tigris River, Iran.

289 (288). The total length of the copulatory organ is 0.032–0.035 mm. The vaginal armament is in the form of a tube, 0.008 –0.010 x 0.003–0.004 mm in size.

D. deziensioides Gussev, Jalali et Molnar, 1993 (Fig. 179)

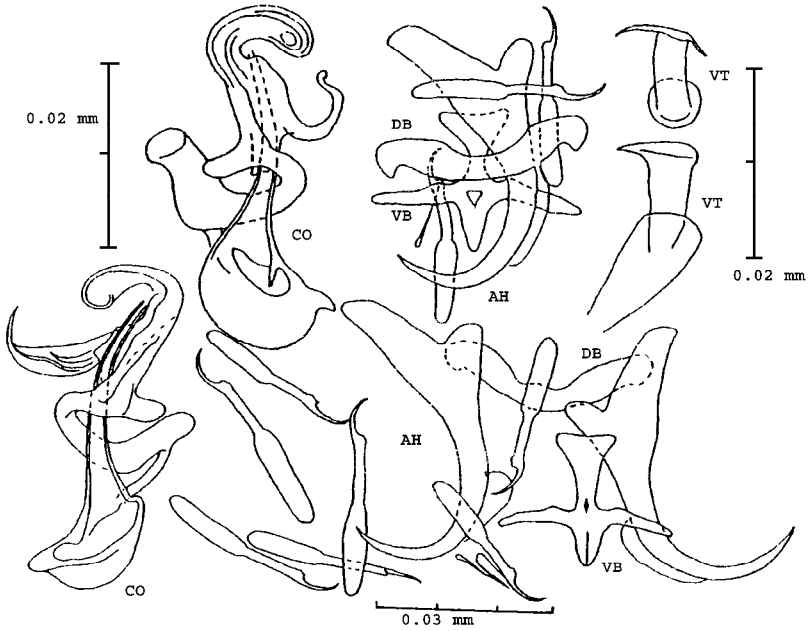
These are small worms; body length can be up to 0.47 mm, width 0.12 mm. Total length of marginal hooks is 0.029–0.033 mm. Length of anchors is 0.041–0.045 mm, main part 0.034–0.038 mm, inner root 0.013–0.018 mm, outer root 0.004–0.005 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.004–0.005 x 0.030–0.037 mm, ventral bar 0.034–0.045 x 0.035–0.040 mm. Length of copulatory organ is 0.032–0.035 mm, diameter of tube 0.003 mm in the middle and 0.014–0.015 x 0.006 mm at the initial part.

Found on *Barbus kersin*; Dez River, water system of the Tigris River, Iran.

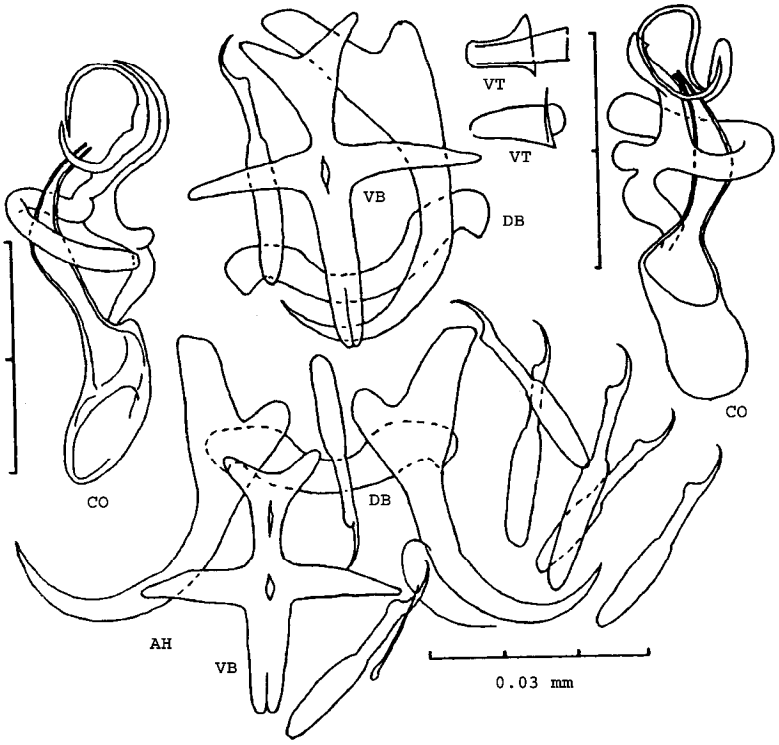
290 (282). The total length of the anchors is less than 0.035 mm.

D. persis Bychowsky, 1949 (Fig. 180)

These worms are minute; body length can be up to 0.25 mm, width 0.06 mm. Length of marginal hooks is 0.017–0.020 mm. Length of anchors is 0.032–0.035 mm, main part 0.023–0.026 mm, inner root 0.009–0.014 mm, outer root 0.003 x 0.004 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.003 x 0.021–0.024 mm, ventral bar 0.021–0.026 x 0.020–0.023 mm. Length of copulatory organ is 0.033 - 0.035 mm. Vaginal armament is absent.



178



179

Fig. 178 – 179.
178 - *Dactylogyrus deziensis* (after Gussev et al., 1993c). **179** - *Dactylogyrus deziensioides* (after Gussev et al., 1993c).

Found on gill filaments of *Barbus lacerta cyri* (found one specimen, if there was no error in identification); in highland tributaries of the Lenkoran' River (Azerbaijan). The first description was from the Karkheh River near the town of Ahvaz (Iran), on gill filaments of *Barbus luteus*.

291 (294). The copulatory organ has a long thin tube that makes 3–4 coils.

292 (293). The copulatory organ has a long thin tube that is 0.270–0.330 mm long. The initial part of the tube is wide and thick walled. The accessory piece is relatively massive.
D. barbuli Gussev, Ali, Abdul-Ameer, Amin et Molnar, 1993 (Fig. 181)

Body length can be up to 1.110 mm, width 0.190 mm. Length of marginal hooks is 0.037–0.043 mm. Length of anchors is 0.060–0.062 mm, main part 0.041–0.045 mm, inner root 0.009–0.010 mm (measurements of outer root is absent), point 0.019–0.021 mm. Size of dorsal bar is 0.006–0.007 x 0.049–0.051 mm, ventral bar 0.040–0.042 x 0.026–0.027 mm. Total length of copulatory organ is 0.070–0.082 mm. Total length of tube along the curve 0.270–0.330 mm, initial part of tube 0.032–0.033 x 0.012–0.017 mm, diameter in middle less than 0.001 mm. Diameter of the coiled vagina is 0.033–0.035 mm, diameter of tube medially 0.001 mm, terminally 0.003 mm.

Found on *Luciobarbus barbulus*; Tigris River, near Baiji, Iran.

293 (292). The copulatory organ has a long thin tube that can be up to 0.500 mm long. The accessory piece is thin and connects to the tear-shaped expanded initial part of the tube by a thin filament.
D. pavlovskyi Bychowsky, 1949 (Fig. 182)

Body length can be up to 0.630 mm, width 0.130 mm. Length of marginal hooks is 0.027–0.034 mm; I and II pairs are shortest. Length of anchors is 0.050–0.065 mm (based partly on data of Bychowsky), main part 0.040–0.056 mm, outer root 0.006–0.017 mm, inner root 0.016–0.022 mm, point 0.014–0.017 mm. Size of dorsal bar is 0.006–0.008 x 0.032–0.042 mm, ventral bar 0.045–0.055 x 0.030–0.040 mm. Total length of copulatory organ is 0.170–0.260 mm, accessory piece 0.055–0.060 mm. Total length of coiled tube can be up to 0.500 mm. Total length of vaginal tube can be up to 0.440 mm; diameter at extremity 0.001 mm, and 0.004 mm in the middle.

Found on *Luciobarbus grypus* and *Barbus sharpeyi*; Dez River, water system of the Tigris River, Iran.

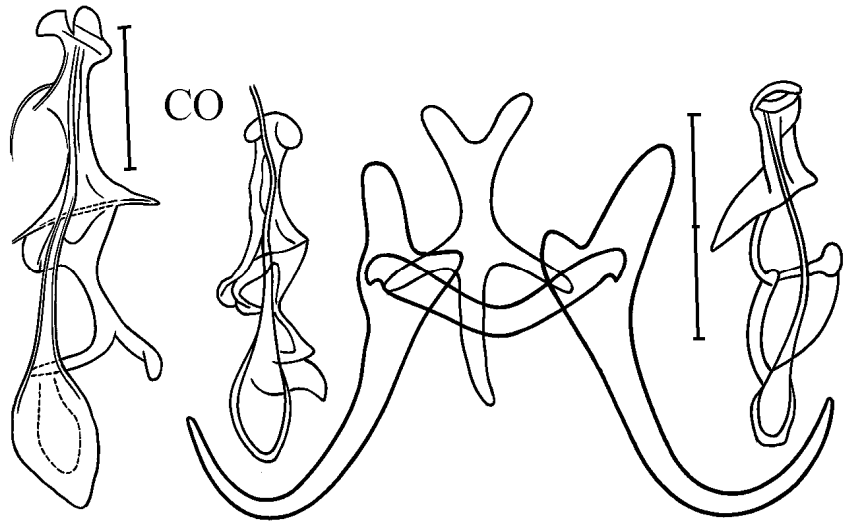


Fig. 180 - *Dactylogyrus persis* (after Bychowsky, 1949).

294 (295). The copulatory tube is spiral shaped; the accessory piece is in form of a wide bowl with a stem. These are parasites of the genera *Barbus* and *Luciobarbus.*

D. affinis Bychowsky, 1933 (Fig. 183)

These are small or medium size worms; body can be up to 0.6 mm long and 0.16 mm wide. Length of marginal hooks is 0.021–0.033 mm. Length of anchors is 0.046–0.065 mm, main part 0.039–0.050 mm, inner root 0.012–0.021 mm, outer root 0.003–0.006 mm, point 0.012–0.015 (first description: 0.018) mm. Size of dorsal bar is 0.004–0.008 x 0.036–0.046 mm, ventral bar 0.034 x 0.050 mm. Length of copulatory organ is 0.037–0.047 mm; the copulatory tube end is not visible because of a saucer-shaped broadening of the accessory piece. Length of the twisted vaginal tube is 0.040–0.050 mm, diameter about 0.0015 mm in the middle, one broad end (diameter about 0.0025 mm) with a small rounded plate.

Found on gill filaments of *Luciobarbus capito*, *L. c. conocephalus*, *L. brachycephalus*, *L. b. caspius*, and *Barbus lacerta cyri*; water bodies of Kazakhstan, Central Asia, and East Transcaucasus.

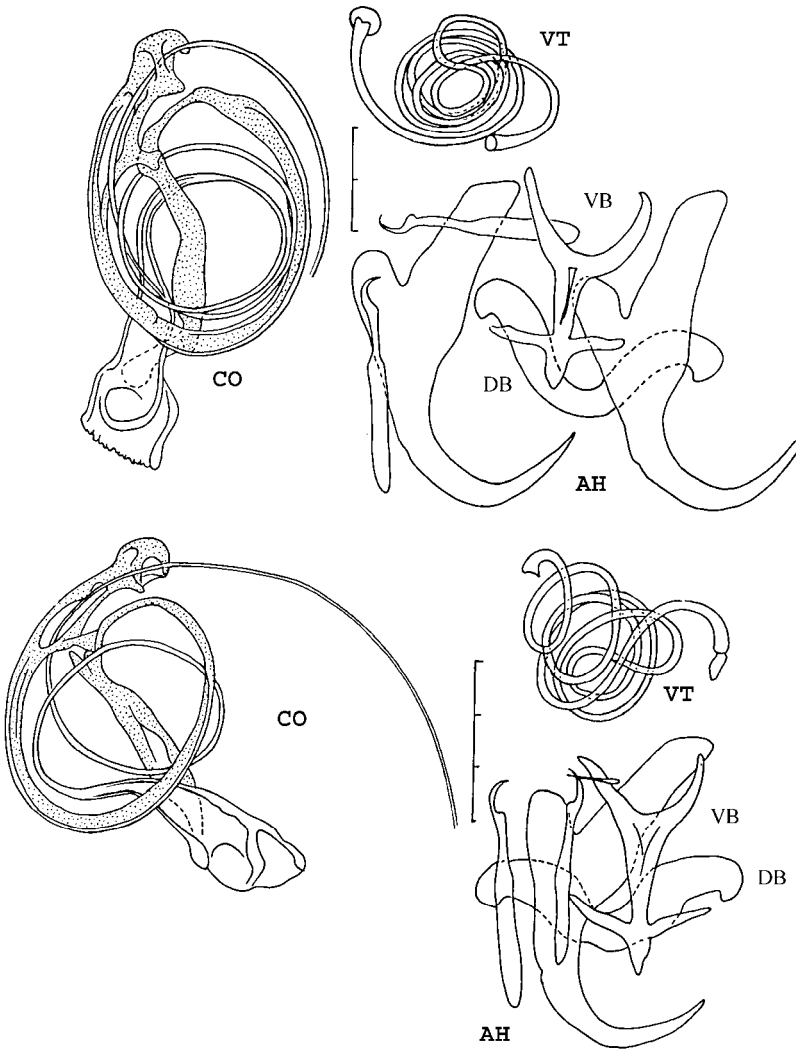


Fig. 181 - *Dactylogyrus barbuli* (after Gussev et al., 1993a).

295 (298). The copulatory tube is sickle shaped; the accessory piece has a broadening and projections at its end. These are parasites of *Blicca* and *Vimba*.

296 (297). The copulatory tube is rather short; the accessory piece resembles a hand mirror. The vaginal tube has a large shield at one end.

D. cornu Linstow, 1878 (Fig. 184)

These are small or medium size worms; body can be up to 0.66 mm long and 0.15 mm wide. Length of marginal hooks is 0.019–0.031 mm. Length of anchors is 0.039–0.049 mm, main part 0.031–0.036 mm, inner root 0.011–0.016 mm, outer root 0.003–0.006 mm, point 0.010–0.013 mm. Size of dorsal bar is 0.003–0.005 x 0.027–0.035 mm, ventral bar 0.021–0.029 x 0.022–0.032 mm. Length of copulatory organ is 0.027–0.037 mm, tube 0.040–0.051 mm. The vaginal tube is 0.028–0.040 mm with a broad rounded plate on one end.

Found on gill filaments of *Blicca bjoerkna* (main host) and *Vimba vimba*; distribution is the same as that of its hosts.

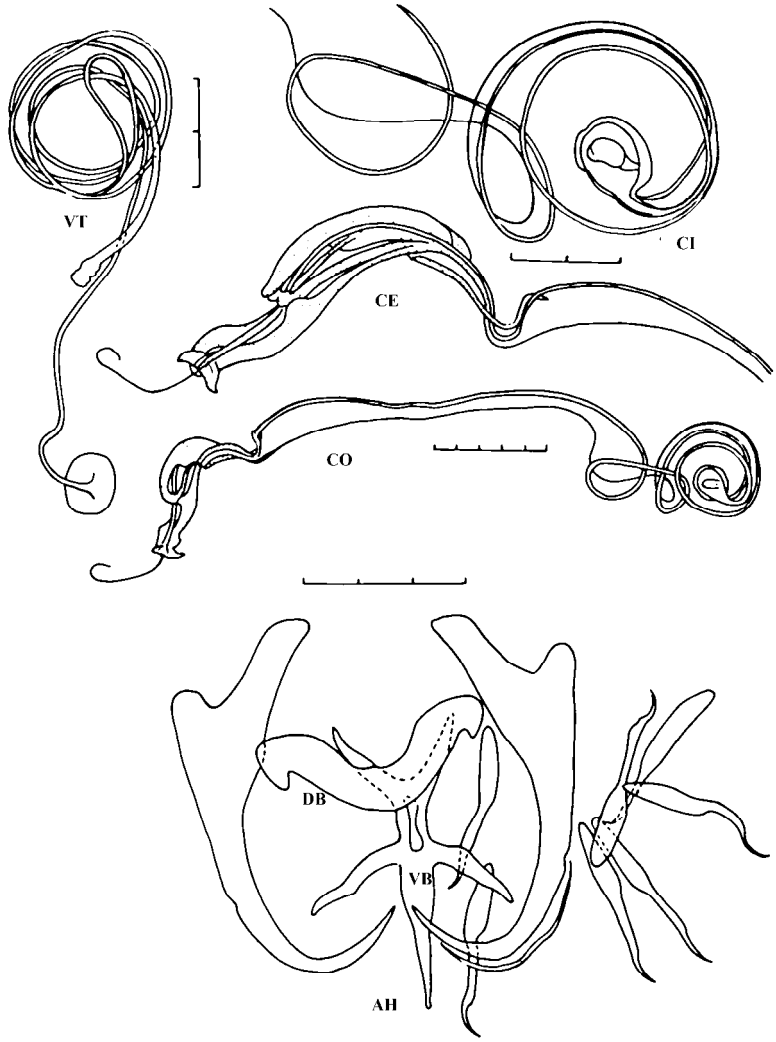
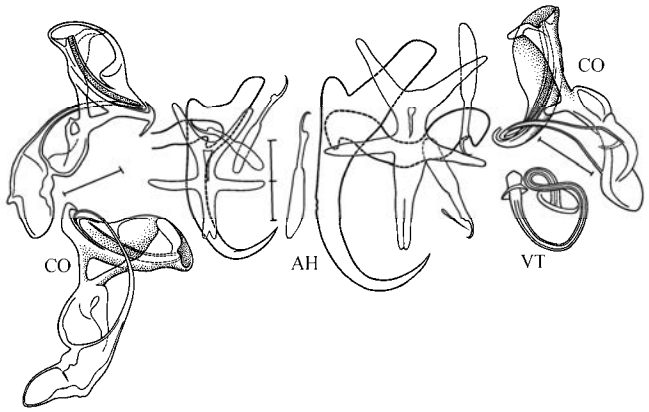
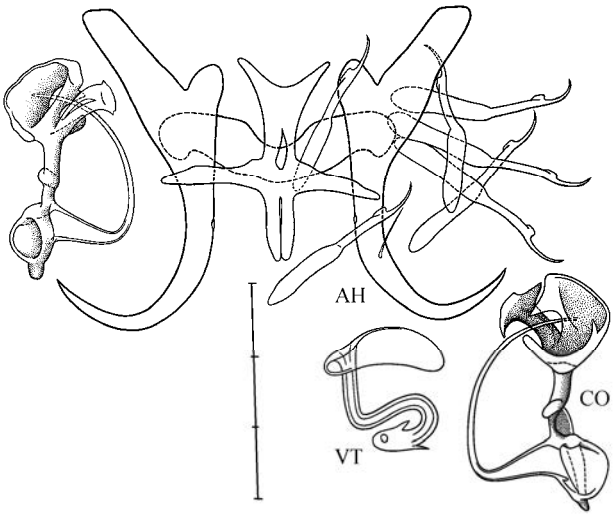


Fig. 182 - *Dactylogyrus pavlovskyi.*

CI – initial part of copulatory organ, CE – enlarged part of accessory piece (after Gussev et al., 1993a).



183



184

Fig. 183-184
183 - *Dactylogyrus affinis.* **184 -** *Dactylogyrus cornu*

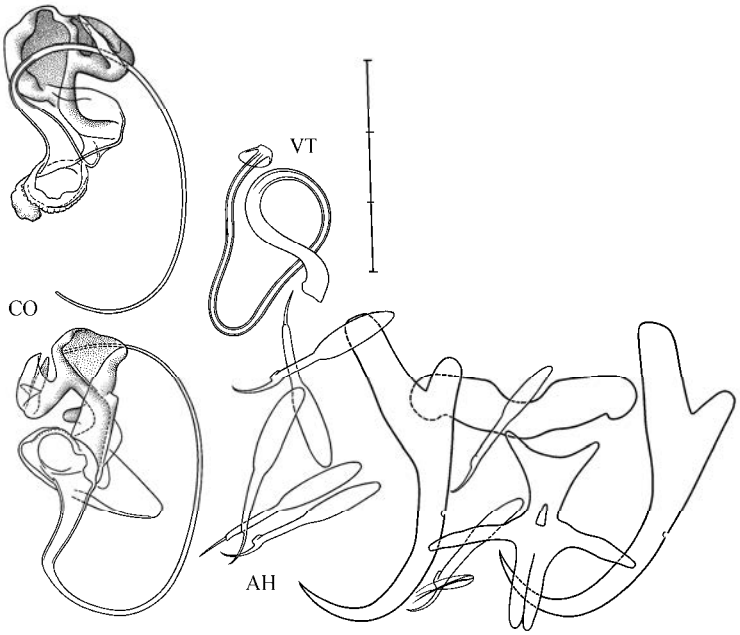


Fig. 185 - *Dactylogyrus cornoides*.

This species has been confused with *D. nanus*, *D. suecicus*, *D. distinguendus*, *D. rutili*, *D. folkmanovae*, *D. nanoides*, and others. All preceding finds on other fishes are not correct or are the result of accidental finds on unusual hosts.

297 (296). The copulatory tube is long; its accessory piece has a broadened end with two claws and an ear-shaped lobe. The vaginal tube is long with a small shield at one end.

D. cornoides Glaeser et Gussev, 1967 (Fig. 185)

These are small or medium size worms; body can be up to 0.66 mm long and 0.15 mm wide. Length of marginal hooks is 0.023–0.035 mm. Length of anchors is 0.041–0.049 mm, main part 0.034–0.040 mm, inner root 0.012–0.015 mm, outer root 0.004–0.007 mm, point 0.010–0.013 mm. Size of dorsal bar is 0.005–0.008 x 0.028–0.035 mm, ventral bar 0.025–0.030 x 0.027–0.030 mm. Total length of copulatory organ is 0.039–0.046 mm, tube along the curve 0.085–0.105 mm; vaginal tube 0.078–0.092 mm.

Found on gill filaments of *Vimba vimba* (main host), *Blicca bjoerkna*, and *Ballerus sapa* (?); its distribution seems to be the same as that of its hosts.

298 (295). The copulatory organ is of the "chondrostomi" type and forms derived from it.[34] These are parasites of Barbinae from northwestern Africa. If the anchors and attachment manner on the gills are of the "sphyrna" type, then the ventral bar is absent.

299 (306). The copulatory organ is of the "chondrostomi" type in the form of a ring. The accessory piece projection is rearward along the circular curved copulatory tube.

300 (305). The anchors are of the "wunderi" type.

301 (302). The length of the distal part of the accessory piece is about 0.010 mm (according to re-measurement of the author's figure). This is a parasite of *Luciobarbus pallaryi*.

[34] See also theses 79, 88, 267.

D. atlasensis El Gharbi, Birgi et Lambert, 1994 (Fig. 186)

Body length is 0.441 (0.374–0.567) mm, width 0.074 (0.046-0.097) mm. Length of marginal hooks of I and II pairs: 0.024 (0.023–0.028) mm, III: 0.030 (0.027–0.032) mm, IV: 0.030 (0.030–0.031) mm, V: 0.031 (0.030–0.032) mm, VI: 0.030 (0.029–0.032) mm, VII: 0.027 (0.024–0.030) mm. Total length of anchors is 0.048 (0.045–0.051) mm, main part 0.035 (0.031–0.038) mm, inner root 0.006 (0.004–0.007) mm, outer root 0.020 (0.016–0.023) mm, point 0.013 (0.011–0.017) mm. Size of dorsal bar is 0.005 (0.004–0.007) x 0.032 (0.027–0.036) mm, ventral bar 0.026 (0.023–0.030) x 0.027 (0.025–0.033) mm. Total length of copulatory organ is 0.026 (0.023–0.029) mm, vaginal armament 0.067 (0.059–0.077) mm.

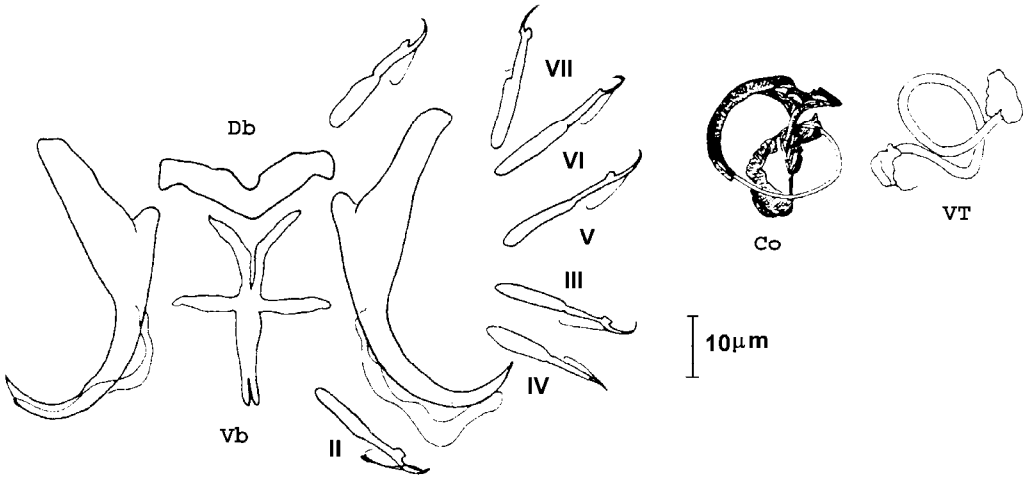
Found on gills of *Luciobarbus pallaryi*; Morocco.

302 (303). The length of the distal part of the accessory piece is about 0.020 mm (according to re-measurement of the author's figure). This is a parasite of *Luciobarbus nanus*.

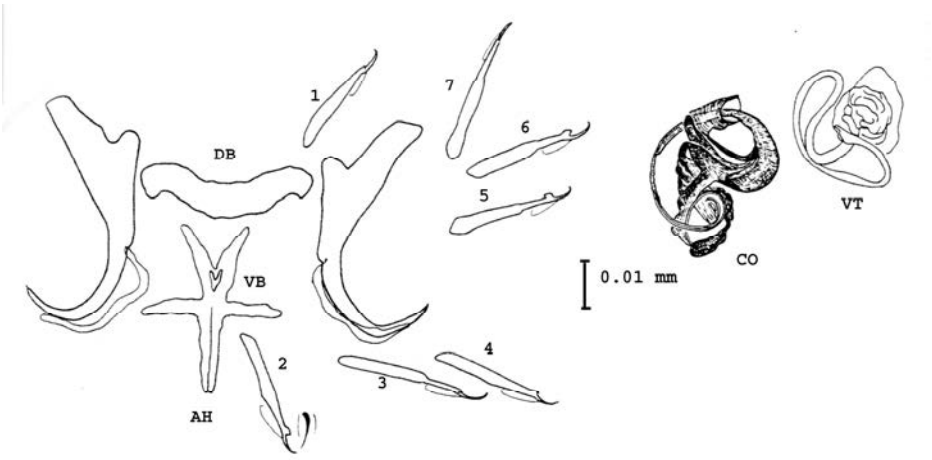
D. borjensis El Gharbi, Birgi et Lambert, 1994 (Fig. 187)

Body length is 0.577 (0.483–0.757) mm and 0.099 (0.075–0.117) mm wide. Length of marginal hooks: I and II: 0.026 (0.019–0.036) mm, III: 0.029 (0.027–0.032) mm, IV: 0.028 (0.024–0.031) mm, V: 0.032 (0.028–0.035) mm, VI: 0.032 (0.028–0.034) mm, VII: 0.029 (0.028–0.030) mm. Length of anchors is 0.049 (0.043–0.058) mm, main part 0.035 (0.032–0.039) mm, outer root 0.006 (0.005–0.008) mm, inner root 0.019 (0.016–0.024) mm, point 0.015 (0.012–0.018) mm. Size of dorsal bar is 0.007 (0.005–0.008) x 0.036 (0.022–0.042) mm, ventral bar 0.029 (0.024–0.032) x 0.036 (0.032–0.043) mm. Length of copulatory organ is 0.038 (0.034–0.044) mm, accessory piece 0.034 mm. Vaginal tube is 0.085 (0.061–0.101) mm long.

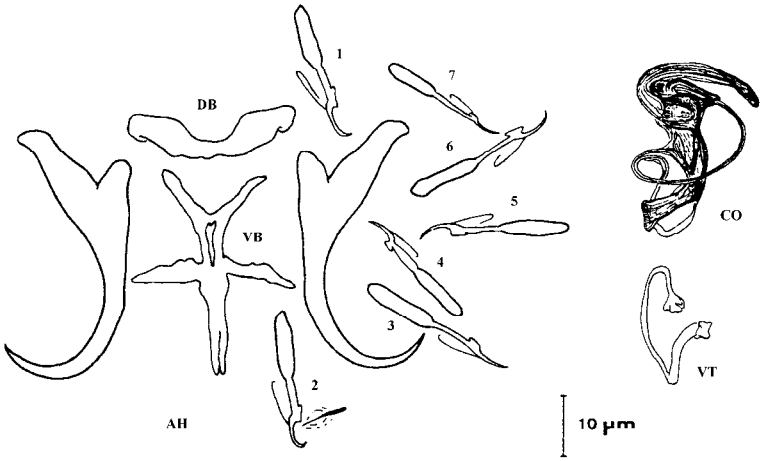
Found on gills of *Luciobarbus nasus*; Morocco.



186



187



188

Fig. 186 – 188.

186 - *Dactylogyrus atlasensis* (after El Gharbi et al., 1994). **187 -** *Dactylogyrus borjensis* (after El Gharbi et al., 1994). **188 -** *Dactylogyrus ksibioides* (after El Gharbi et al., 1994).

303 (304). The length of the distal part of the accessory piece is 0.013 mm (from El Gharbi et al., 1994). This is a parasite of *Luciobarbus setivimensis* and *L. moulouyensis.*

D. ksibioides El Gharbi, Birgi et Lambert, 1994 (Fig. 188)

Average body length in samples from two barbell species (after El Gharbi et al., 1994) is 0.368–0.502 (general variability 0.248–0.686) mm and average width is 0.081–0.093 (general variability 0.058–0.121) mm. Average length of marginal hooks: I: 0.023–0.028 (general variability 0.022–0.032) mm, II: 0.023–0.026 (0.022–0.028) mm, III: 0.027–0.030 (0.024–0.033) mm, IV: 0.025–0.032 (0.023–0.036) mm, V: 0.026–0.030 (0.022–0.034) mm, VI: 0.027–0.031 (0.023–0.036) mm, VII: 0.026–0.029 (0.023–0.034) mm. Average total length of anchors is 0.041–0.052 (general variability 0.038–0.059) mm, main part 0.032–0.039 (0.030–0.045) mm, outer root 0.006–0.007 (0.004–0.009) mm, inner root 0.015–0.021 (0.013–0.025) mm, point 0.011–0.014 (0.010–0.016) mm. Average size of dorsal bar is 0.004–0.005 (0.003–0.008) x 0.029–0.032 (0.025–0.036) mm, ventral bar 0.027–0.031 (0.023–0.033) x 0.028–0.038 (0.025–0.045) mm. Average length of copulatory organ is 0.026–0.029 (general variability 0.023–0.031) mm. Average length of vaginal armament is 0.043–0.058 (general variability 0.031–0.075) mm.

Found on gills of *Luciobarbus setivimensis* (type host) and *L. moulouyensis*; Morocco.

304 (303). The length of the distal part of the accessory piece is 0.007 mm (from El Gharbi et al., 1994). This is a parasite of *Luciobarbus ksibi, L. setivimensis,* and *L. magniatlantis*.[35]

D. ksibii El Gharbi, Birgi et Lambert, 1994 (Fig. 189)

Average body length in samples from three barbell species (after El Gharbi et al., 1994) is 0.376–0.523 (general variability 0.276–0.654) mm and average width is 0.072–0.088 (0.049–0.114) mm. Length of marginal hooks: I: 0.027 (0.026–0.029) mm, II: 0.025 (0.024–0.027) mm, III: 0.030 (0.029–0.032) mm, IV: 0.031 (0.028–0.033) mm, V: 0.033 (0.026–0.037) mm, VI: 0.031 (0.026–0.034) mm, VII: 0.030 (0.025–0.036) mm. Average total length of anchors is 0.046–0.055 (0.037–0.068) mm, main part 0.034–0.044 (0.028–0.047) mm, outer root 0.006–0.007 (0.004–0.008) mm, inner root 0.016–0.021 (0.013–0.026) mm, point 0.012–0.014 (0.010–0.018) mm. Average size of dorsal bar is 0.005–0.006 (0.003–0.007) x 0.030–0.033 (0.022–0.039) mm, ventral bar 0.028–0.030 (0.021–0.036) x 0.034–0.036 (0.030–0.045) mm. Average length of copulatory organ is 0.025–0.027 (general variability 0.023–0.032) mm. Average length of vaginal armament is 0.045–0.052 (general variability 0.031-0.074) mm.

Found on gills of *Luciobarbus ksibi* (type host), *L. setivimensis*, and *L. magniatlantis;* Morocco.

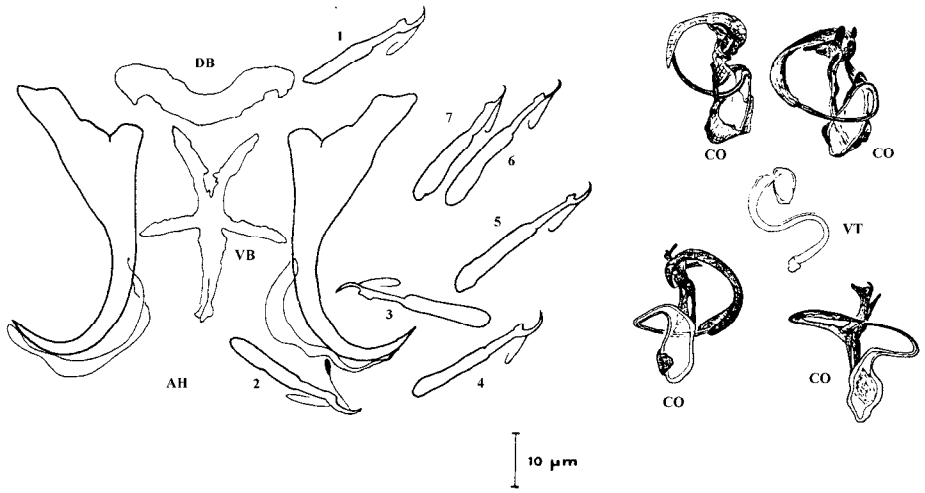
305 (300). The haptor and anchors are of the "sphyrna" type. The VII pair of marginal hooks is 1.5 longer than the other marginal hooks. The ventral bar is absent.

D. guirensis El Gharbi, Birgi et Lambert, 1994 (Fig. 190)

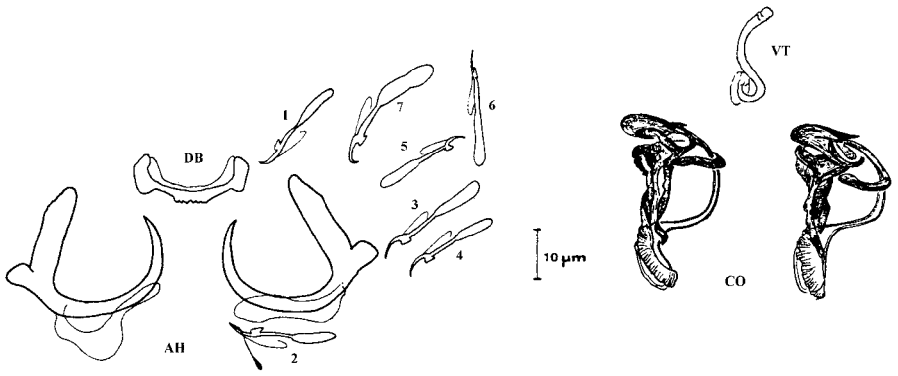
Body length is 0.569 (0.467–0.692) mm and width is 0.084 (0.068–0.095) mm. Length of marginal hooks: I-VI: 0.021 (0.018–0.025) mm, VII: 0.028 (0.026–0.029) mm. Total length of anchors is 0.027 (0.025–0.029) mm, main part 0.022 (0.020–0.027) mm, outer root 0.005 (0.003–0.006) mm, inner root 0.019 (0.016–0.020) mm, point 0.018 (0.016–0.020) mm. Size of dorsal bar is 0.004 (0.003–0.006) x 0.024 (0.020–0.026) mm, ventral bar 0.026 (0.023–0.030) x 0.027 (0.025–0.033) mm. Length of copulatory organ is 0.038 (0.035–0.044) mm, accessory piece 0.033 (0.029–0.038) mm. Vaginal armament is 0.030 (0.023–0.036) mm.

Found on gills of *Luciobarbus pallaryi*; Morocco.

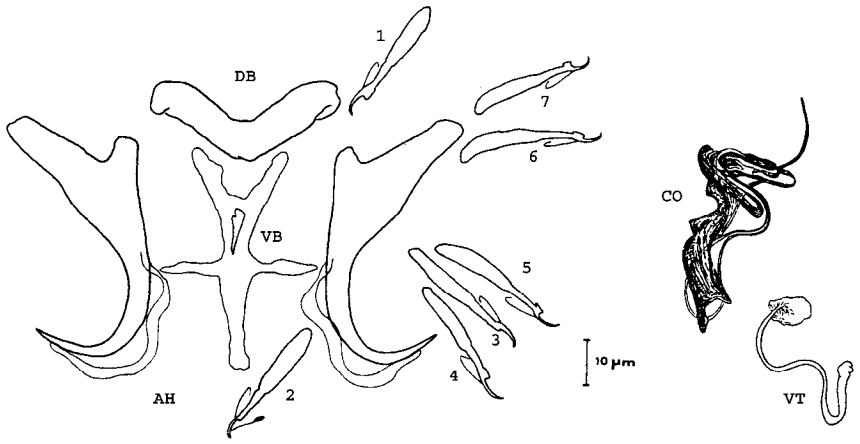
[35] Last four species are in need of redescription and accurate definition.



189



190



191

Fig. 189 – 191.

189 - *Dactylogyrus ksibii* (after El Gharbi et al., 1994). **190-** *Dactylogyrus guirensis* (after El Gharbi et al., 1994). **191 -** *Dactylogyrus draaensis* (after El Gharbi et al., 1994).

306 (307). The long copulatory tube does not form a ring but looks like antrorse corkscrew or is in the form of a strongly curved letter **S**. The accessory piece projection is relatively small. The copulatory organ is of the elongated "chondrostomi" form.

D. draaensis El Gharbi, Birgi et Lambert, 1994 (Fig. 191)

Body length is 0.590 (0.453–0.697) mm and 0.086 (0.062–0.115) mm wide. Length of marginal hooks: I: 0.029 (0.025–0.033) mm, II: 0.033 (0.032–0.035) mm, III: 0.033 (0.032–0.035) mm, IV: 0.031 (0.029–0.036) mm, V: 0.034 (0.033–0.037) mm, VI: 0.033 (0.031–0.037) mm, VII: 0.031 (0.029–0.034) mm. Total length of anchors is 0.056 (0.053–0.059) mm, main part 0.043 (0.041–0.045) mm, outer root 0.007 (0.005–0.008) mm, inner root 0.022 (0.021–0.023) mm, point 0.016 (0.015–0.018) mm. Size of dorsal bar is 0.007 (0.005–0.009) x 0.043 (0.039–0.044) mm, ventral bar 0.035 (0.033–0.036) x 0.049 (0.042–0.054) mm. Length of copulatory organ is 0.043 (0.039–0.046) mm. Length of vaginal armament is 0.052 (0.042–0.059) mm.

Found on gills of *Barbus paytonii*; Morocco.

307 (308). The copulatory tube and vaginal armament are very long, curved spirally in the form of a corkscrew, and make more than four coils. The accessory piece is situated completely within the copulatory tube spiral. The copulatory organ is of "chondrostomi" type.

D. heteromorphus El Gharbi, Birgi et Lambert, 1994 (Fig. 192)

Body length is 0.334 (0.303–0.392) mm and width is 0.064 (0.068–0.058) mm. Length of marginal hooks is 0.027 (0.025–0.030) mm. Total length of anchors is 0.052 (0.050–0.054) mm, main part 0.041 (0.038–0.043) mm, outer root 0.006 (0.006–0.007) mm, inner root 0.017 (0.016–0.019) mm, point 0.014 (0.013–0.015) mm. Size of dorsal bar is 0.005 (0.004–0.007) x 0.033 (0.030–0.035) mm, ventral bar 0.033 (0.032–0.037) x 0.047 (0.043–0.051) mm. Length of copulatory organ is 0.038 (0.036–0.042) mm.

Found on gills of *Luciobarbus callensis*; Morocco.

308 (307). The copulatory tube is a short S-like curve that forms half of a coil. The copulatory organ is of the modified "chondrostomi" type.

309 (310). The vaginal armament ends with a spacious sclerotized bladder. The accessory piece is situated above the initial part of the copulatory tube.

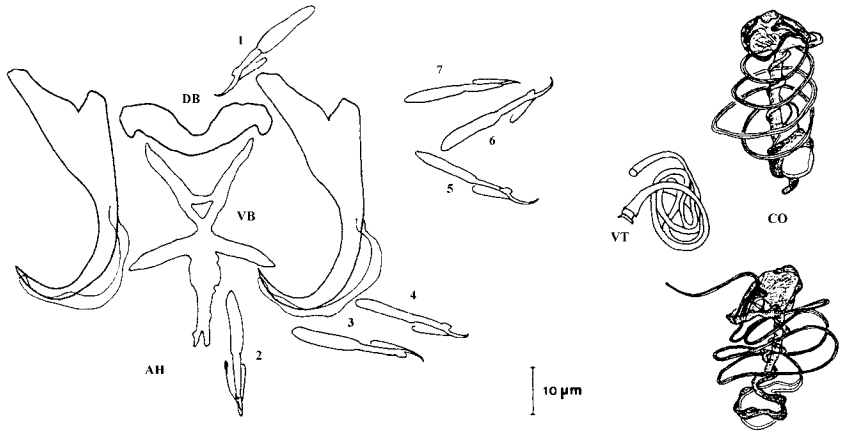
D. tunisiensis El Gharbi, Birgi et Lambert, 1994 (Fig. 193)

Body length is 0.352 (0.276–0.489) mm, width 0.058 (0.049–0.071) mm. Length of marginal hooks: I: 0.022 (0.019–0.025) mm, II: 0.022 (0.020–0.025) mm, III: 0.023 (0.019–0.026) mm, IV: 0.027 (0.026–0.028) mm, V: 0.025 (0.025–0.026) mm, VI: 0.025 (0.021–0.027) mm, VII: 0.023 (0.022–0.024) mm. Total length of anchors is 0.043 (0.038–0.048) mm, main part 0.033 (0.030–0.037) mm, outer root 0.006 (0.005–0.008) mm, inner root 0.014 (0.011–0.016) mm, point 0.013 (0.011–0.014) mm. Size of dorsal bar is 0.005 (0.003–0.006) x 0.028 (0.025–0.031) mm, ventral bar 0.029 (0.025–0.033) x 0.034 (0.028–0.039) mm. Total length of copulatory organ is 0.027 (0.024–0.029) mm. Length of vaginal armament is 0.012 (0.009–0.013) mm.

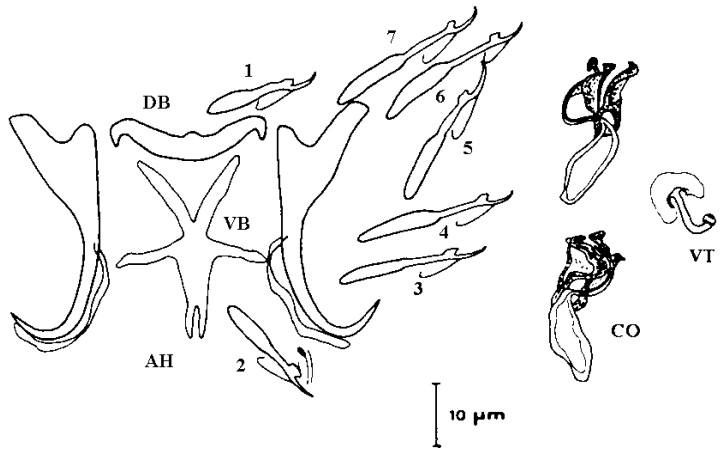
Found on gills of *Luciobarbus callensis*; Morocco.

310 (309). The vaginal armament ends with a plate. The accessory piece is massive and embraces the initial part of the copulatory tube.

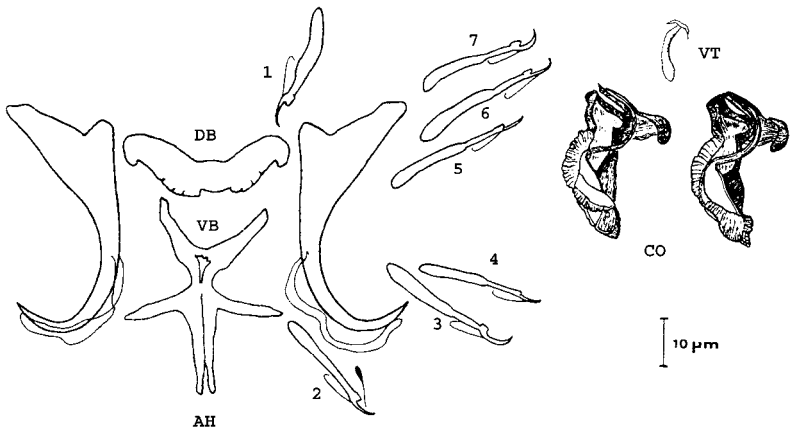
D. fimbriphallus El Gharbi, Birgi et Lambert, 1994 (Fig. 194)



192



193



194

Fig. 192 – 194.
192 - *Dactylogyrus heteromorphus* (after El Gharbi et al., 1994). **193 -** *Dactylogyrus tunisiensis* (after El Gharbi et al., 1994). **194 -** *Dactylogyrus fimbriphallus* (after El Gharbi et al., 1994).

The average body length in samples from six barbell species (after El Gharbi et al., 1994) is 0.355–0.561 (general variability 0.256–0.706) mm and average width is 0.061–0.087 (general variability 0.044–0.112) mm. Length of marginal hooks is 0.019–0.032 mm. Average total length of anchors is 0.042–0.046 (general variability 0.039–0.051) mm, main part 0.033–0.038 (0.019–0.033) mm, outer root 0.005–0.008 (0.004–0.009) mm, inner root 0.013–0.017 (0.012–0.019) mm, point 0.012–0.014 (0.010–0.016) mm. Average size of dorsal bar is 0.002–0.004 (0.002–0.005) x 0.030–0.036 (0.024–0.039) mm, ventral bar 0.027–0.032 (0.023–0.037) x 0.035–0.038 (0.028–0.040) mm. Average length of copulatory organ is 0.027–0.033 (general variability 0.024–0.037) mm, tube 0.038–0.048 mm. Average length of vaginal armament is 0.011–0.013 (general variability 0.008–0.015) mm.

Found on gills of *Luciobarbus figuiensis* (type host), *L. lepineyi*, *L. massaensis*, *L. moulouyensis*, *L. pallaryi*, and *L. issenensis;* Morocco.

Supplement to Palaearctic species of *Dactylogyrus*

I. Several species of the genus *Dactylogyrus* described from western Europe and Russia can not be identified.

a) *D. megastoma* Wagener, 1857 was described from the gills of *Rhodeus amarus* found in Germany. This species seems to be *D. vastator* or *D. crassus* according to very good drawings by the author. The anchors and marginal hooks, copulatory organ, and dorsal bar are of the "vastator–crassus" type, but the latter is in two variations. This is curious because both of the mentioned species have only one bar and no known species has this combination. The host also is unusual for *D. vastator* and *D. crassus*, but it could be an occasional find because specimens of *D. vastator* are sometimes found on other fish species. If this is the case, then one of these species should be regarded as a synonym of *D. megastoma*. Because *D. megastoma* has not been found since 1857, then this name is regarded as "nomen oblitum" according to paragraph 23 of the International Code of Zoological Nomenclature (1999).

b) *D. falcatus* Wedl, 1857 was described from the gills of an unidentified cyprinid fish from a water body near to Vienna. Later Wegener (1909) identified as *D. falcatus* one young specimen from the gills of *Blicca bjoerkna* and published a drawing. Since then the name *D. falcatus* has been attached to one of four species specific to *Abramis brama.* It is obvious that Wegener dealt with occasional specimens from *Blicca bjoerkna*. Careful analysis of the drawing published by Wedl (1857) shows that it contains structures not of *D. falcatus* sensu Wegener but of *D. vastator*, which was described as a new species at a later date. The marginal hooks of the specimen described by Wedl are very long and similar to the dorso-apical length of the anchors. This is the case with *D. vastator* but not *D. falcatus*. This specimen sensu Wegener has marginal hooks that are less than 2/3 of the dorso-apical length of the anchors. The dorsal bar and especially the copulatory organ of Wedl's drawing do not resemble the same structures on Wegener's drawing but instead are similar to *D. vastator*. We conclude that *D. megastoma* Wagener, *D. falcatus* Wedl, and *D. vastator* Nybelin represent only one species. If we reject *D. megastoma* (as "nomen oblitum"), two species are left. It is possible to view *D. vastator* as a synonym of *D. falcatus* and to give a new name to the species found on *Abramis brama*. However, if we refer to the discussion in the preceding paragraph, to avoid confusion this should not be done.

c) *D. mollis* Wedl, 1857 was described from gill filaments of *Cyprinus carpio* from a water body near Vienna. There are no species of *Dactylogyrus* from carp that have a ventral bar (especially a ⊥–shaped bar), but it is present in Wedl's original drawing. Identification of this species using the drawing is impossible. *D. nanus*, *D. suecicus*, *D. ramulosus*, *D. difformis*, and others have been found on *Cyprinus carpio* occasionally. Alarotu's (1944) identification of *D. mollis* as *D. difformis* seems to be invalid. *D. mollis* should be considered a "species inquirenda."

d) *D. tenuis* Wedl, 1857 was described from the gills of *Perca fluviatilis* caught in a water body near Vienna. There are no representatives of *Dactylogyrus* with five rays on the ventral bar found on perch, but is present in the drawing. It might be *D. cornu*, *D. carpathicus*, and others found occasionally on this host. Identification of this cannot be done without investigation of origi-

nal material. This species, as well as *D. mollis*, has not been found a second time and should be considered a "species inquirenda."

e) Identification by Wagener (1857) of species found on the gills of *Gobio fluviatilis* as *D. major* and on gills of *Rutilus rutilus* as *D. trigonostoma* lack drawings and descriptions and should be considered as typical "nomen nudum."

f) *D. skworzowi* Layman, 1950, *D. seligeri* Layman, 1950, and *D. parvulus* (Layman, 1951) have no descriptions, and the latter has no drawing. Drawings of the first two are so primitive that it is quite impossible to identify the parasite and its host using them (Fig. 195: A, B). Data found in the theses of the Key of *Dactylogyrus* (Layman, 1951a) are not enough. All three of these species, as well as *D. joriensis* (Fig. 195: C), should be considered "species inquirenda."

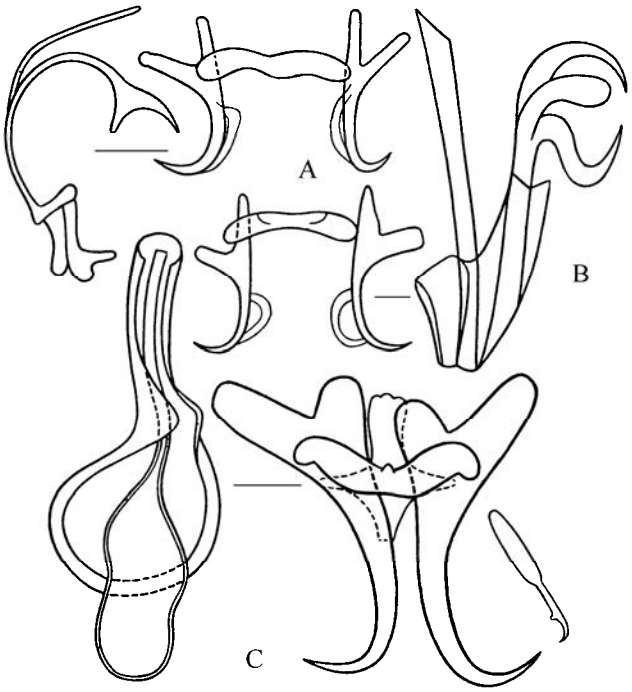


Fig. 195. A – *Dactylogyrus skworzowi*, B – *Dactylogyrus seligeri* (after Layman, 1951a), C – *Dactylogyrus joriensis* (after Chiaberaschvili, 1968): all figures are without scales.

II. Bychowsky (1936) described a *Dactylogyrus* sp. from gill filaments of *Alburnoides taeniatus* from the Chu River (Kazakhstan). This short description states only that the specimens have a ⊥-shaped ventral bar. The copulatory organ is also given (Fig. 196: B). Agapova (1945) identified this species as the new species *Neodactylogyrus bychowskii*, which has been found in same fish from the basin of the Syrdar'ya River (Fig. 196 A). This species name has been preoccupied therefore in the Key of 1962 it had been given a new name *D. agapovae* Gussev. However, analysis of all data published by Bychowsky et Agapova has shown that identification of *D. agapovae* as *D.* sp. Bychowsky, 1936 was incorrect. The latter is more similar to *D. rarissimus* from *Rutilus rutilus*. It is difficult to say using Agapova's description and drawings what species she found. Until new data are available, *D. agapovae* is to be considered a "species inquirenda."

Key to *Dactylogyrus* species from Amur River fishes[36]

1 (2). The haptor lacks bars. Sometimes a very thin dorsal bar (ratio of width to length 1:20) is present. The copulatory organ is of the "anchoratus" type. The marginal hooks are long; they are similar in length or longer than the anchors; the anchors are highly variable, especially in the shape and size of the main part and roots; their wings are very thin and poorly visible.
D. yinwenyingae Gussev, 1962 (Fig. 7)

2 (1). The haptor has one or two bars; the marginal hooks in most cases are shorter than the anchors; anchor shape is stable; the wings are easily visible. The copulatory organ is of different types.

3 (49). Only one bar (dorsal) is present in the haptor.

4 (7). The anchors have an open point that with the shaft forms a single whole (blade) that is bent only at its tip ("falcatus - vastator" type).

5 (6). The copulatory tube is rather broad, thin walled, and bent like a bracket with smooth walls; at its initial part it is like a funnel and then it is cylindrical and oblique at its end.
D. vastator Nybelin, 1924 (Fig. 8, 10, 11)[37]

6 (5). The copulatory tube is rather narrow, thick-walled, and wavy with a corkscrew-shaped ridge that tapers to its end.
D. achmerovi Gussev, 1955 (Fig. 12)[38]

7 (4). The anchors have a declinate point that turns into the shaft by a more or less visible bend (other types of anchors).

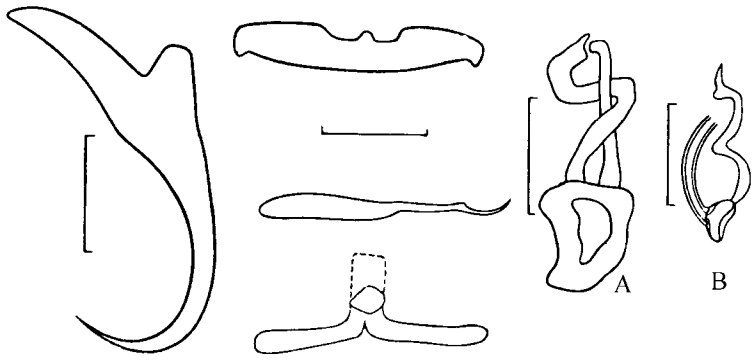
8 (11). The total length of the anchors is 1.5–2 times shorter than that of the dorsal bar.

9 (10). The anchors and dorsal bar are massive; the dorsal bar has well-developed roots; the copulatory tube is long and involute to a flat spiral. These are parasites of *Leuciscus waleckii*.
D. robustus Malewitzkaja, 1941 (Fig. 20)

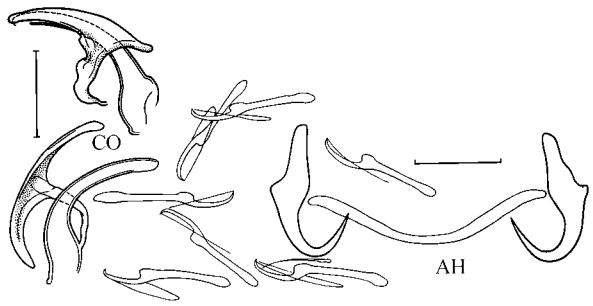
[36] Data used here and in the Supplement are from Chinese publications (f.e. Chen et al., 1973). Authors of parts of the book are not named, but drawings of Monogenoidea surely were done by the late Lyng Mo En.

[37] *D. crassus* may be also found in the Amur region.

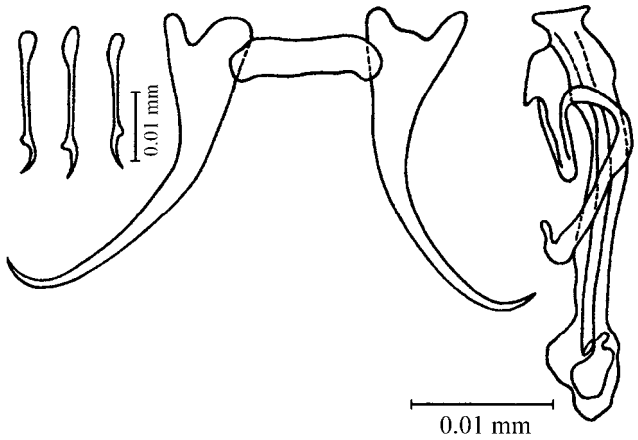
[38] A similar species, *D. biwaensis* Ogawa et Egusa, 1982, was described in Japan from *Cyprinus carpio rubrofuscus*.



196



197



198

Fig. 196 – 198.
196 - A – "*Neodactylogyrus bychowskii*" (after Agapova, 1945), B – copulatory organ of *Dactylogyrus* sp. (after Bychowsky, 1936). **197 -** *Dactylogyrus singularis* (after Gussev, 1955a). **198 -** *Dactylogyrus barbatuli* (after Ermolenko, 2003).

10 (9). The anchors are thin and lack an outer root; the dorsal bar is narrow (ratio of width to length 1:20). The copulatory organ is a short sickle-shaped tube. These are parasites of *Sarcocheilichthys czerskii*.

D. singularis Gussev, 1955 (Fig. 197)

These are minute worms; body length can be up to 0.30 mm and width 0.08 mm. Length of marginal hooks is 0.014–0.018 mm. Length of anchors is 0.013–0.015 mm, main part 0.009–0.010 mm, inner root 0.004–0.006 mm, point 0.005–0.006 mm. Size of dorsal bar is 0.001–0.002 x 0.027–0.033 mm. Total length of copulatory organ is 0.020 mm. Vaginal armament is absent.

Worms attachment to gill filaments are similar to *Bivaginogyrus* and *Dogielius*: the broad haptor clasps the gill filament using second and third pairs of marginal hooks and anchors those points are turned inside.

Found on gill filaments of *Sarcocheilichthys czerskii*; basin of Lake Khanka.

11 (8). The anchors are longer than the dorsal bar in most cases.

12 (36). The anchors are of different types; both roots are developed. These are predominantly parasites of genera *Carassius* and *Cyprinus,* one species on *Barbatula.*

13 (14). The anchors have equal and relatively small roots; the point length is less than the root length. This is a parasite of *Barbatula.*

D. barbatuli Ermolenko, 2003 (Fig. 198)

These are small worms; body length can be up to 0.4 mm. Length of marginal hooks is 0.019–0.023 mm. Length of anchors is 0.039–0.041 mm, main part 0.036–0.039 mm, roots 0.006–0.007 mm, point 0.003–0.004 mm. Size of dorsal bar is 0.004–0.005 x 0.02 mm. Total length of copulatory organ is 0.033–0.034 mm, tube width about 0.001 mm.

Found on gills of *Barbatula toni*; Poima River (southern Maritime Territory) and the Ussuri River, Russia.

14 (17). The copulatory tube is very long (more than 0.2 mm) and thin and twisted into a flat spiral; a long vaginal tube is present.

15 (16). A long copulatory tube with three spires is present. The anchors are a rather curious **[**-like shape (the inner root deviates from the axis of the main part by more than 90°); the outer root is very small; the handle of the marginal hook is long. This is a parasite of *Cyprinus carpio rubrofuscus.*

D. falciformis Akhmerov, 1952 (Fig. 199)

These small worms have a body length up to 0.45 (in Chen et al. (1973) up to 0.96) mm and width 0.10 (0.21) mm. Length of marginal hooks is 0.022–0.037 mm. Length of anchors: dorsoapical 0.043–0.052 mm, main part 0.043–0.045 mm, inner root 0.018–0.027 mm, outer root 0.003–0.006 mm, point 0.025–0.029 mm. Size of dorsal bar is 0.003–0.007 x 0.033–0.039 mm. Length of copulatory tube along the curve is 0.19–0.22 mm; diameter of its bubble-shaped initial part about 0.008 mm, afterwards 0.003–0.005 mm. Length of spiral twisted vaginal tube about 0.12 mm, diameter 0.001 mm.

Found on gill filaments of C*yprinus carpio rubrofuscus*; Amur River; Lake Khanka; basin of the Yangtze River.

Worms attachment to gill filaments seems to be of the "anchoratus" type (anchors claw hold of gill filament tissue from one side and from another side second and third pairs of marginal hooks do the same using their points).

16 (15). The copulatory organ has 2–2.5 spires. The anchors are a common shape (the inner root deviates from the axis of the main part by less than 45°); they are short and massive and have a small but easily visible outer root; the marginal hooks are similar to the larval type and have a small oval handle.

This is a parasite of ***Rhodeus sericeus***.

D. papillus Jukhimenko, 1981 (Fig. 200)

These are medium and large size worms; body can be up to 1.5 mm long and 0.15 (?) mm wide. Length of marginal hooks is 0.013–0.018 mm. Length of anchors is 0.027–0.043 mm, main part 0.018–0.030 mm, inner root 0.010–0.014 mm, outer root 0.004–0.005 mm, point 0.017–0.021 mm. Size of dorsal bar is 0.005–0.010 x 0.013–0.019 mm. Length of copulatory tube along the curve is 0.30–0.35 mm, diameter of initial part about 0.010 mm, of other part 0.001–0.004 mm. Length of vaginal tube (straight at funnel-shaped end and with loops at the other end) 0.10–0.16 mm, diameter about 0.003 mm.

Found on the ovipositor of ***Rhodeus sericeus***; Amur River near Khabarovsk (Russia).

17 (14). The copulatory tube is relatively short (less than 0.11 mm), wide, and straight or weakly bent. The vaginal armament may be absent or present as a short funnel or bubble.

18 (23). The length of the anchors is greater than 0.060 mm.

19 (20). The dorsal bar is longer than the main part of the anchors; the inner root is equal to or slightly shorter than the main part. The vaginal armament is absent. This is a parasite of ***Carassius auratus gibelio***.

D. dogieli Gussev, 1953 (Fig. 201)

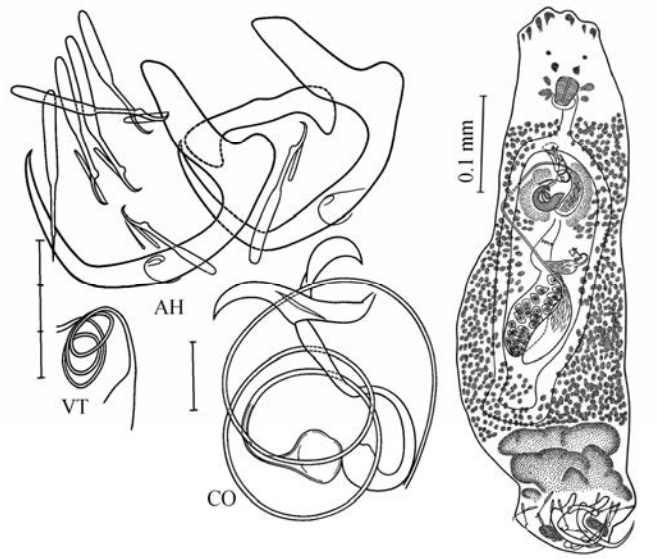


Fig. 199 - *Dactylogyrus falciformis* (after Gussev, 1955a; total drawing from dorsal view – after Ogawa et Egusa, 1982).

These are large worms; body can be up to 1.0 mm long and 0.3 mm wide. Length of marginal hooks is 0.027–0.034 mm. Length of anchors is 0.068–0.082 mm, main part 0.040– 0.049 mm, inner root 0.029–0.040 mm, outer root 0.004–0.008 mm, point 0.029–0.035 mm. Size of dorsal bar is 0.006–0.008 x 0.049–0.062 mm. Length of **S**-shaped copulatory tube is 0.065–0.074 mm, diameter in its middle 0.005–0.007 mm. The simple rachis-like accessory piece is pointed at its end.

Found on gill filaments of ***Carassius auratus gibelio***; Amur River.

20 (19). The dorsal bar is noticeably shorter than the main part of the anchors; the main part of anchors is 2.5–3 times longer than the inner root. The vaginal armament may or may not be present. These are parasites of *Cyprinus carpio rubrofuscus*.

21 (22). The anchors are relatively narrow and long. The copulatory tube is **Γ** shaped and almost

cylindrical; its initial part is a funnel. The vaginal armament is absent.
D. extensus Mueller et Van Cleave, 1932 (Fig. 22, 23).

22 (21). The anchors are of the "macracanthus" type and are relatively broad and short. The copulatory tube is slightly curved and tapers to its end; the initial part is very massive and has a large projection; this part is twice as long as the tube itself. The vaginal armament is present.
D. mrazeki Ergens et Dulmaa, 1969 (Fig. 202)
Syn.: *D. cornucirrus* Strelkov, 1971

These are large worms; body can be up to 1.3 mm long and 0.3 mm wide. Length of marginal hooks is 0.035–0.049 (in Strelkov (1971): 0.056–0.060) mm. Length of anchors is 0.067–0.078 mm, main part 0.049–0.064 mm, inner root 0.026–0.033 mm, outer root 0.010–0.017 mm, point 0.036–0.040 mm. Size of dorsal bar is 0.010–0.015 x 0.052–0.063 mm. Total length of copulatory organ is 0.067–0.079 mm, tube 0.033–0.035 mm. Length of vaginal tube is 0.032–0.041 mm.

Found on gill filaments of *Cyprinus carpio rubrofuscus*; Kerulen (Mongolia), Amur (Russia), and Yangtze (China) Rivers; water bodies of Japan.

23 (18). The length of the anchors is less than 0.056 mm.

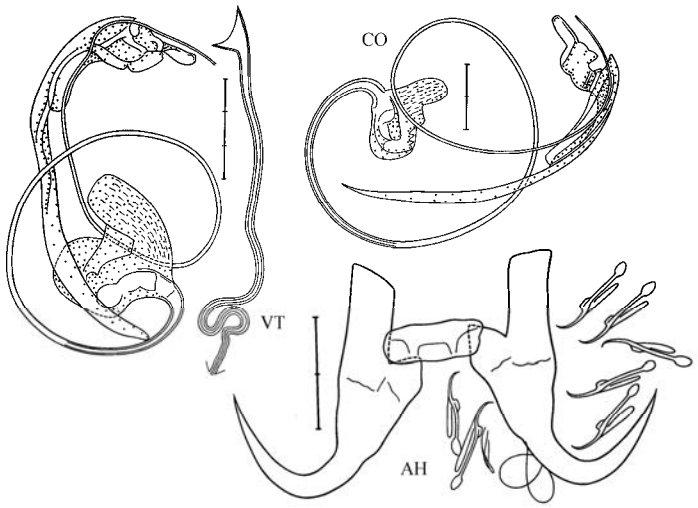
24 (27). The length of the anchors is less than 0.035 mm; the point is sabre-shaped and turns into the shaft smoothly without an abrupt bend.

25 (26). The anchors are thin; the marginal hooks are nearly the same length as the bar and anchors or even longer. The vaginal armament is rounded with a short tube. This is a parasite of the genus *Carassius*.
D. intermedius Wegener 1910 (Fig. 25)

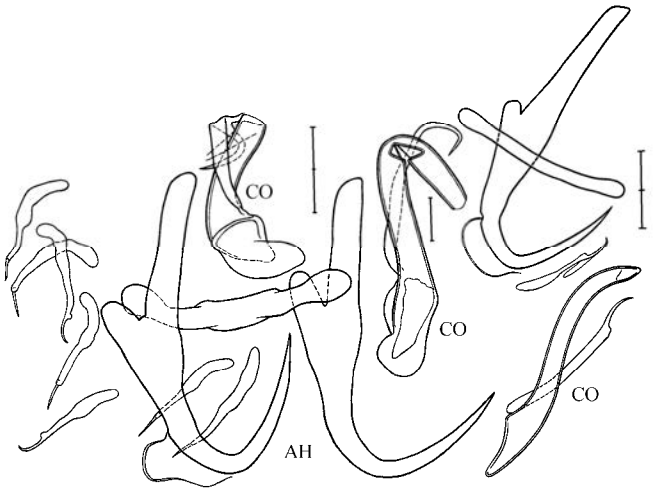
26 (25). The anchors are massive; the marginal hooks are not longer than 3/4 the length of the anchors and of the bar. The vaginal armament is absent. This is a parasite of Xenocypris macrolepis.
D. ornithorrhynchus Tchang et Ji, 1980 (Fig. 203)
Syn.: *D. junchisi* Jukhimenko, 1981

These are small or medium size worms; body can be up to 0.64 mm long and 0.14 mm wide. Length of marginal hooks is 0.015–0.019 mm. Length of anchors is 0.025–0.030 mm, main part 0.020–0.025 mm, inner root 0.008–0.013 mm, point 0.011–0.013 mm. Size of dorsal bar is 0.003–0.005 x 0.023–0.029 mm. Length of copulatory organ is 0.033–0.039 mm, tube diameter in its middle part about 0.003 mm.

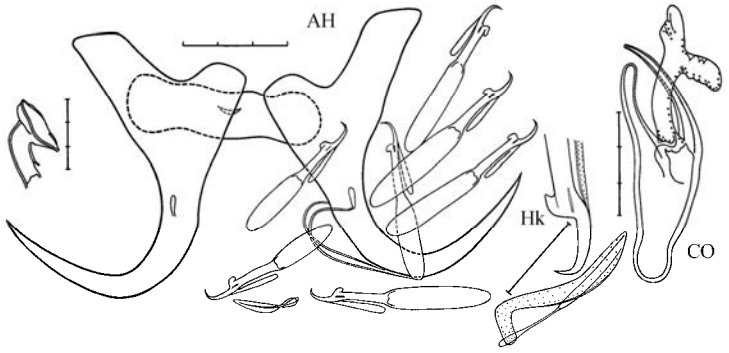
Found on gill filaments of *Xenocypris macrolepis*; Amur River near Khabarovsk. In China it has been reported for *Plagiognathops microlepis* in the Yangtze River.



200



201



202

Fig. 200 – 202.
200 - *Dactylogyrus papillus* (after Jukhimenko, 1981). **201 -** *Dactylogyrus dogieli*. **202 -** *Dactylogyrus mrazeki* (after Jukhimenko, 1981).

27 (24). The anchors point turns into the shaft with an abrupt bend; the length of the anchors is greater than 0.040 mm.

28 (35). The anchors are of the "wunderi" type; they are relatively thin and long and have an inner root that is 3–4 time longer than the outer one. The dorsal bar lacks a projection; the marginal hooks are thin. The thin copulatory tube is curved. These are parasites of Cyprinus carpio rubrofuscus.

29 (32). The copulatory tube is **S** shaped; its prolonged initial part has a short projection that is directed forward. The vaginal armament is mushroom shaped.

30 (31). The accessory piece of the copulatory organ is an **S**-bent rachis-like plate with a small lateral projection and an enlarged flattened end.
D. lopuchinae Jukhimenko, 1981 (Fig. 204)
Syn.: *Dactylogyrus* sp.1 Gussev, 1955

These are small worms; body can be up to 0.5 mm long and 0.15 mm wide. Length of marginal hooks is 0.024–0.036 mm. Length of anchors is 0.042–0.052 mm, main part 0.037–0.044 mm, inner root 0.016–0.021 mm, outer root 0.005–0.009 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.005–0.007 x 0.025–0.032 mm. Length of copulatory organ is 0.035–0.041 mm. Length of vaginal tube is about 0.012 mm.

Found on gill filaments of *Cyprinus carpio rubrofuscus*; Lake Khanka, Amur River near Khabarovsk (Russia).

31 (30). The accessory piece of the copulatory organ resembles a **Γ**–shaped curved rachis-like plate with a "muff" in the middle and a rounded end.
D. molnari Ergens et Dulmaa, 1969 (Fig. 205)

These are small worms; body can be up to 0.52 mm long and 0.13 mm wide. Length of marginal hooks is 0.023–0.032 mm. Length of anchors is 0.044–0.056 mm, main part 0.037–0.048 mm, inner root 0.015–0.020 mm, outer root 0.003–0.007 mm, point 0.013–0.017 mm. Size of dorsal bar is 0.005–0.007 x 0.029–0.035 mm. Length of copulatory organ is 0.027–0.033 mm, vaginal tube 0.011 mm, diameter of mushroom like vaginal cap 0.013–0.016 mm.

Found on gill filaments of *Cyprinus carpio rubrofuscus*; Rivers Kerulen (Mongolia) and Amur near Khabarovsk, Lake Bolon' (Russia).

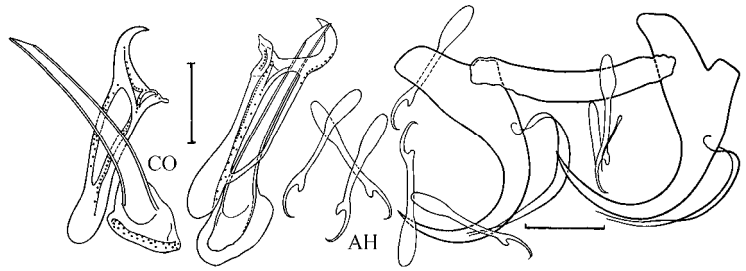
32 (29). The copulatory tube is nearly straight or wavy. The vaginal armament is absent.

33 (34). The copulatory tube is slightly wavy with an outgrowth on the prolonged initial part. The dorsal bar is 1.5 times shorter than the main part of the anchor.
D. minutus Kulwiec, 1927 (Fig. 27)[39]

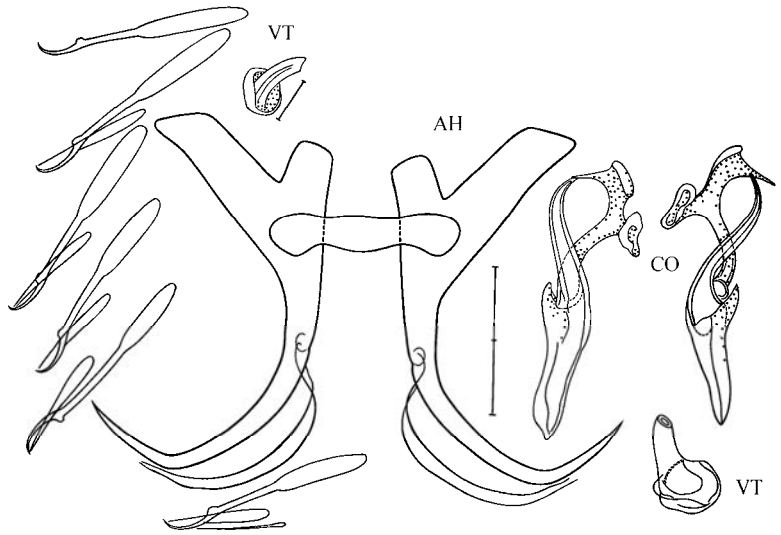
34 (33). The copulatory tube is straight with a posterior outgrowth on the initial part. The dorsal bar is as long as or longer than the main part of the anchors.
D. sahuensis Ling, 1965 (Fig. 206)
Syn.: *Dactylogyrus* sp. 2 Gussev, 1955

These are small worms; body can be up to 0.44 mm long and 0.14 mm wide. Length of marginal hooks is 0.024–0.036 mm. Length of anchors is 0.050–0.054 mm, main part 0.041 mm, inner root 0.018–0.021 mm, outer root 0.003–0.004 mm, point 0.019–0.021 mm. Size of dorsal bar is 0.005 x 0.037–0.052 mm. Length of copulatory organ is 0.047–0.058 mm.

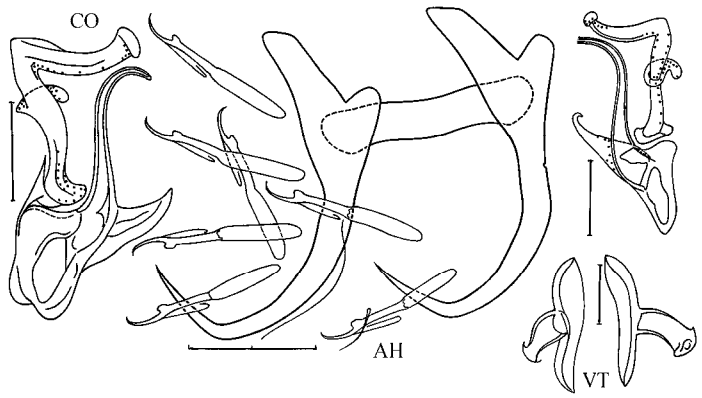
[39] A similar species, *D. takahashii* Ogawa et Egusa, 1982, has been described from *Cyprinus carpio rubrofuscus* in Japan.



203



204



205

Fig. 203 – 205.
203 - *Dactylogyrus ornithorrhynchus* (after Jukhimenko, 1981). **204 -** *Dactylogyrus lopuchinae* (after Jukhimenko, 1981). **205 -** *Dactylogyrus molnari* (after Jukhimenko, 1981).

Found on gill filaments of *Cyprinus carpio rubrofuscus*; Lake Khanka (Russia); Yangtze River (China); water bodies of Japan.

35 (28). The anchors are of the "robustus" type according the ratio of their parts, but the border between the inner part and the point is sharper; the dorsal bar has a short anterior projection; the marginal hooks are very massive. The copulatory tube is very broad and short. This is a parasite of *Pseudaspius leptocephalus* and *Tribolodon brandtii*.

D. pseudaspii Gussev, 1953 (Fig. 207)

Syn.: *D. iwanowi* Bychowsky, 1957?

These worms can be different sizes; body can be up to 1.5 mm long and 0.5 mm wide. Length of marginal hooks is 0.037–0.045 mm. Length of anchors is 0.046–0.055 (dorso- apical length, the ventro-apical length is slightly shorter), main part 0.037–0.041 mm, inner root 0.018–0.020 mm, outer root 0.008–0.012 mm, point 0.020 mm. Size of the dorsal bar is 0.008–0.014 (at ends 0.016) x 0.040–0.048 mm. The copulatory organ is of the "anchoratus" type; the tube has a high cone -shape, broad at the main part and narrowing to its end; length 0.041–0.051 mm, width of the initial part 0.015–0.019 mm.

Found on gill filaments of *Tribolodon brandtii* and *Pseudaspius leptocephalus*; Amur River (Lake Chlya), Peter the Great Bay (Russia).

The description of *D. iwanowi* Bychowsky, 1957 from *Tribolodon brandtii* was not published. It was mentioned several times by Bychowsky (1957a) and now should be considered a "nomen nudum." The number of slides from the Zoological Institute collection has been revised, and additional material was gathered in 1979 from Peter the Great Bay by Timofeeva. The study yielded an astonishing result. Timofeeva's specimens on glycerine-gelatine slides (length up to 1.16 mm and width 0.18 mm) had poorly developed vitelline glands as well as chitinoid structures that were identical to those of specimens gathered by Bychowsky from *Pseudaspius leptocephalus* and used as syntypes for the description of *D. pseudaspii* (collection of fishes from 03.08.1902, Lake Chlya).

Examination of all slides of *D. "iwanowi"* gathered by Bychowsky (ZIN RAS collection specimens of *Tribolodon brandtii*, Peter the Great Bay, summer 1931) revealed the presence not only of specimens (length 0.4–1.7 mm) with poorly developed vitelline glands and chitinoid structures (in some small worms the marginal hooks had short undeveloped handle), but also very large worms up to 3.5 mm length. The body of the first group is oval and broad.

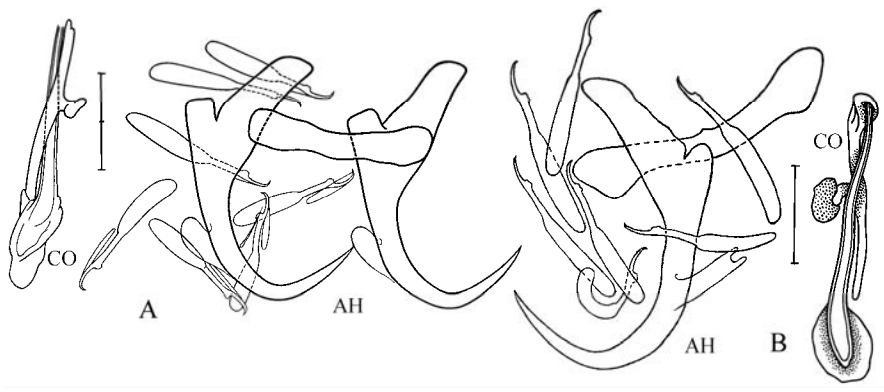


Fig. 206 - *Dactylogyrus sahuensis*: A – after Gussev, 1955a, B – after Chen et al., 1973.

The last third of the body of the second group is prolonged into a long peduncle; the first two thirds of the body are full of well-developed vitelline glands, between which a narrow clear space is visible. The haptor armament is similar to that of *D. pseudaspii*. The copulatory organ has the same cone-shaped or sometimes even broader tube and the same accessory piece. In one specimen the tube and its accessory piece are very similar to that of *D. vastator* or *D. crassus* (see Fig. 207 B, to the right). The tube in large specimens has a long massive fibrous straight projection. Its length is up to 0.13 mm, whereas the tube is only 0.040 mm long (in the specimen with the "vastator"-like tube, this projection is thinner and shorter and only 0.08 mm long).

All of these data indicate that on both mentioned fishes one *Dactylogyrus* species—but two forms of it—are present: only young (?) worms on *Pseudaspius*, but young and mature ones on *Tribolodon*. These two types represent age forms but not two different species. How this species became established on two hosts and why only young specimens have been found on *Pseudaspius* remains a mystery. A study of the peculiarities of the life cycle of *D. pseudaspii* on *T. brandtii* (Bychowsky, 1957a) should be conducted.

The main host of this species likely is *T. brandtii*. This fish enters rivers for spawning. Reproduction of the parasite takes place during this period. One part of *D. pseudaspii* larvae infects the mature and young specimens of *T. brandtii* that have not reached sea water and that stay in the river for the winter. Another part of larvae infects *Pseudaspius*. The genera *Tribolodon* and *Pseudaspius* are very similar to one another therefore it is no wonder that one *Dactylogyrus* species infects fishes of both genera. *Tribolodon brandtii* infected by this parasite stay in the river during the whole summer (young fishes even longer), thereby inhabiting the same water bodies as *Pseudaspius*, yet infection of the latter fish is rather low. Only one specimen out of 26 investigated by the Amur Expedition (1958–1960) was infected and only one specimen of *D. pseudaspii* has been found (Strelkov, 1971). It is possible that during the sea period (2–3 years), growth and reproduction of *D. "iwanowi"* pauses. Therefore, immature worms on seaward bound fishes remain undeveloped during the sea period and they occur simultaneously with worms which have become mature during riverine period. However, this supposition remains to be confirmed.

Perhaps *D. pseudaspii* is a rare species (if not unique) of dactylogirids with a life cycle that lasts one full year or even more.

36 (12). The anchors are of the "anchoratus" type; they lack an outer root but have a long and thin inner root. These are parasites of *Carassius* (*D. anchoratus* also is found on *Cyprinus carpio*).

37 (38). The dorsal bar is in the shape of an upturned **П**. The copulatory tube is bottle shaped; its initial part has a comb-like outgrowth; the projection of the accessory piece as well as its main branch are bifurcated.
D. formosus Kulwiec, 1927 (Fig. 32).

38 (37). The dorsal bar is straight or bent slightly backwards. The copulatory tube is cylindrical or tapers to its end; its initial part lacks a comb-like outgrowth (sometimes it has a small tongue-shaped projection); the accessory piece lacks projections or has simple (not bifurcated) projections.

39 (42). The anchors are very long (greater than 0.090 mm) and their inner root is twice as long as the point. The ratio of the bar's length to width is 1:2.5–1:4.

40 (41). The copulatory tube is slightly bent and nearly cylindrical; the accessory piece is in the form of a plate with a transverse projection.
D. anchoratus (Dujardin, 1845) (Fig. 33)

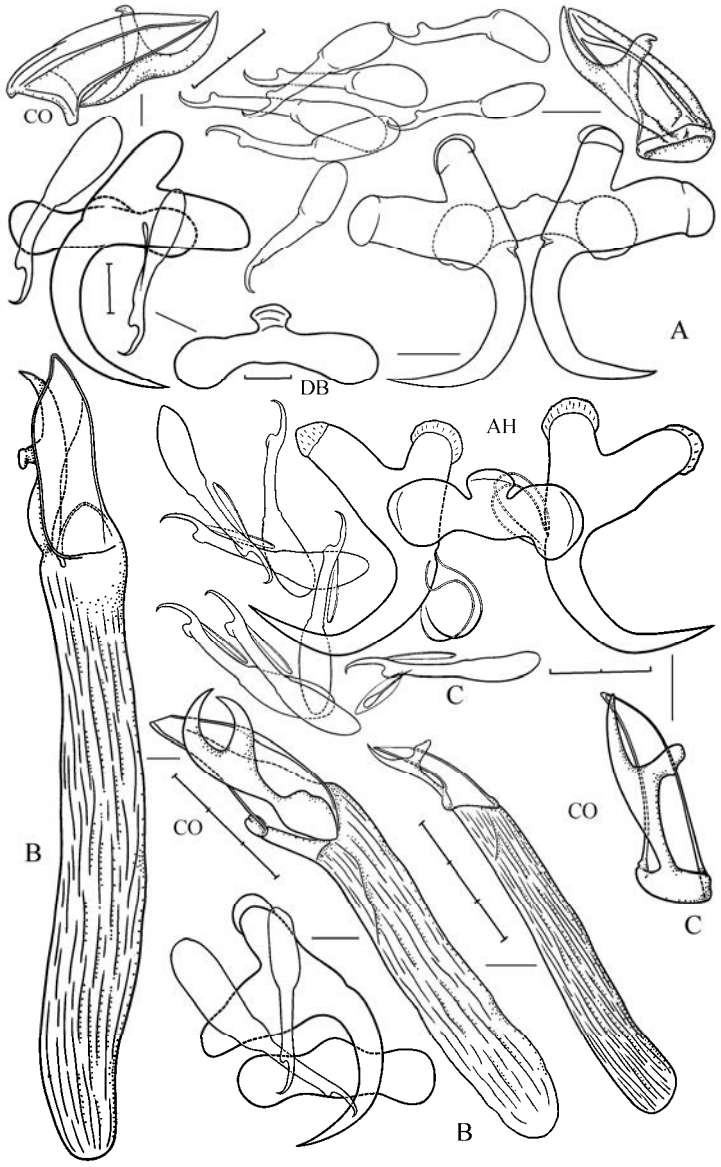


Fig. 207- *Dactylogyrus pseudaspii*.

A – specimen from ***Pseudaspius leptocephalus*** Amur River (Lake Chlya, Russia) without or with poorly developed vitelline glands, body length 0.45-0.9 mm; B – specimen from ***Tribolodon brandtii*** (Peter the Great Bay, Russia) with well developed vitelline glands, body length 1.7-3.5 mm; C – specimen from ***Tribolodon brandtii*** (Peter the Great Bay, Russia) without or with poorly developed vitelline glands, body length up to 1.26 mm.

41 (40). The copulatory tube is sickle shaped and tapers to the end; the accessory piece is in the form of a bent rachis-like plate without projections.
D. arcuatus Yamaguti, 1942 (Fig. 208)
Syn.: *D. anchoratus geei* Yin et Sproston, 1948; *D. geei*: Gussev, 1953

These are small worms; body can be up to 0.45 mm long and 0.12 mm wide. Length of marginal hooks is 0.015–0.027 (0.015–0.030)[40] mm. Length of anchors is 0.090–0.120 mm, main part 0.058–0.065 mm, inner root 0.054–0.068 (0.054–0.074) mm, point 0.023–0.031 mm. Size of dorsal bar is 0.007–0.010 x 0.018–0.025 mm. Total length of copulatory organ is 0.040–0.053 mm, tube along the curve 0.065–0.075 mm. Vaginal armament is a chitinoid bubble, diameter 0.009–0.014 mm.

Found on gill filaments of *Carassius auratus gibelio* and *C. carassius*; Lena and Amur (Russia) Rivers; Yangtze River (China); water bodies of Japan.

42 (39). The length of the anchors is less than 0.065 mm; the inner root is as long as or slightly longer than the point; the ratio of the bar's length and width is 1:8–1:15.

43 (44). The copulatory tube is spiral, narrow, and tapers to the end; the accessory piece is enlarged at the end and lacks projections. The ratio of the length and width of the bar is 1:15.
D. spiralis Yamaguti, 1942 (Fig. 209)

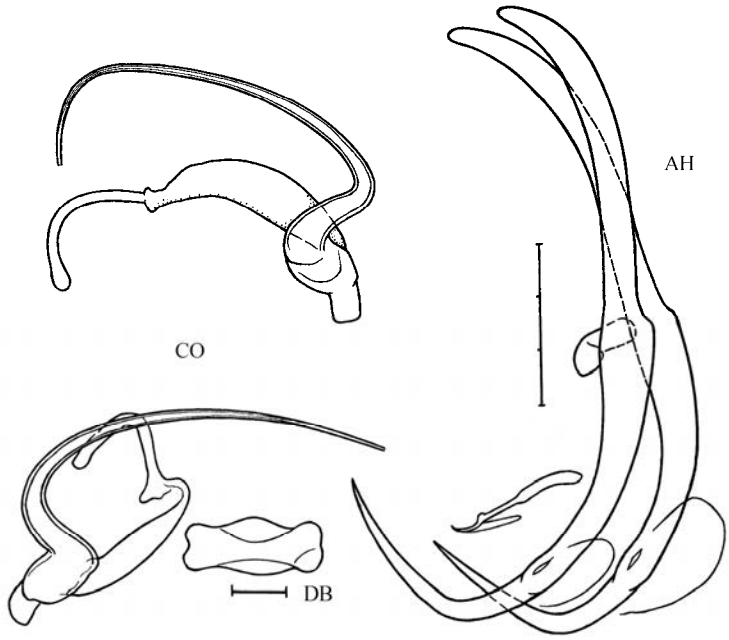


Fig. 208 - *Dactylogyrus arcuatus* (after Gussev, 1953).

[40] Values in brackets are from the first description.

These are small worms; body can be up to 0.40 mm long and 0.06 mm wide. Length of marginal hooks is 0.017–0.024 (0.015–0.033)[41] mm. Length of anchors is 0.052–0.065 (0.040–0.052) mm, main part 0.033–0.037 mm, inner root 0.024–0.031 (0.020–0.026) mm, point 0.024–0.028 (0.018–0.024) mm. Size of dorsal bar is 0.002–0.004 x 0.028–0.037 mm. Length of copulatory tube along the curve is 0.045–0.053 mm. Vaginal tube is thin, length 0.009–0.013 mm, diameter 0.0014–0.002 mm.

Found on gill filaments of *Carassius auratus*; Amur River near Khabarovsk (Russia); water bodies of Japan.

44 (43). The copulatory tube is rather broad and weakly tapers to the end. The ratio of the bar length to width is 1:8–1:9.

45 (46). The copulatory tube is sickle shaped; the accessory piece has a "trefoil" at the end; two beak-shaped anterior projections are bent towards each other.
D. baueri Gussev, 1955 (Fig. 35)

46 (45). The copulatory tube is nearly straight.

47 (48). The copulatory tube has thin walls; the anterior broadening of the accessory piece is straightened and spade-like with thickened borders.
D. dulkeiti Bychowsky, 1936 (Fig. 36)

48 (47). The copulatory tube has thick walls; the end of the accessory piece is spanner-like.
D. inexpectatus Izjumova in Gussev, 1955 (Fig. 37)

49 (3). Two bars, dorsal and ventral, are present in the haptor.

50 (53). The anchors lack roots; the ventral bar is a broad transverse ribbon that is bent backwards or forwards (on squeezed specimens).[42]

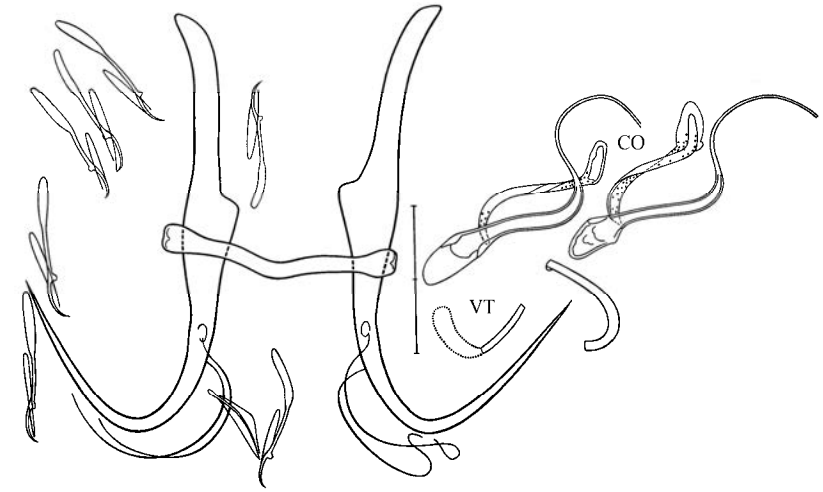
51 (52). The marginal hooks have a prominent heel of the point; the length of the anchors is less than 0.035 mm. The accessory piece has a forked end. Length of the VI pair of marginal hooks is less than the length of the anchors.
D. juveniformis Gussev, 1953 (Fig. 210)

These are small worms; body can be up to 0.41 mm long and 0.09 mm wide. Length of marginal hooks is 0.016–0.032 mm. Length of anchors is equal to that of the main part, 0.028–0.033 mm, point 0.010– 0.012 mm. Size of dorsal bar is 0.002–0.003 x 0.019–0.023 mm, ventral bar 0.003–0.004 x 0.018–0.020 mm. Total length of copulatory organ is 0.020–0.025 mm, tube 0.025–0.030 mm. Vaginal armament is absent.

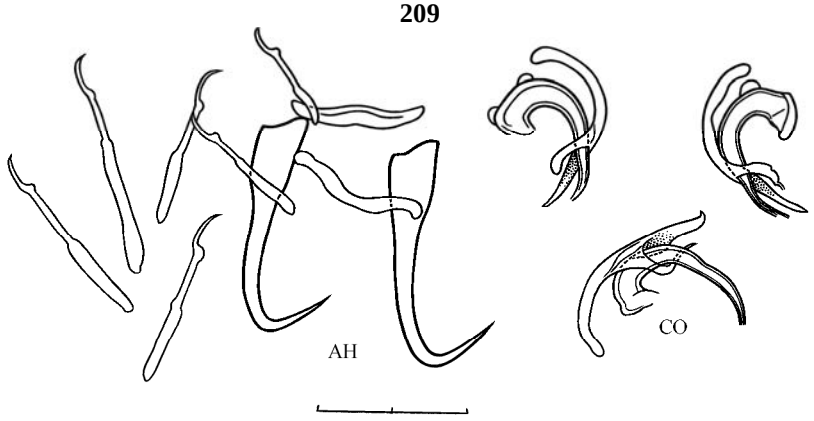
Found on gill filaments of *Xenocypris macrolepis*; basin of Amur River (Russia); Liao He and Yangtze Rivers (China).

52 (53). The length of the VI pair of marginal hooks is greater than the length of the anchors.
D. limleehongae Gussev, 1985 (Fig. 211)

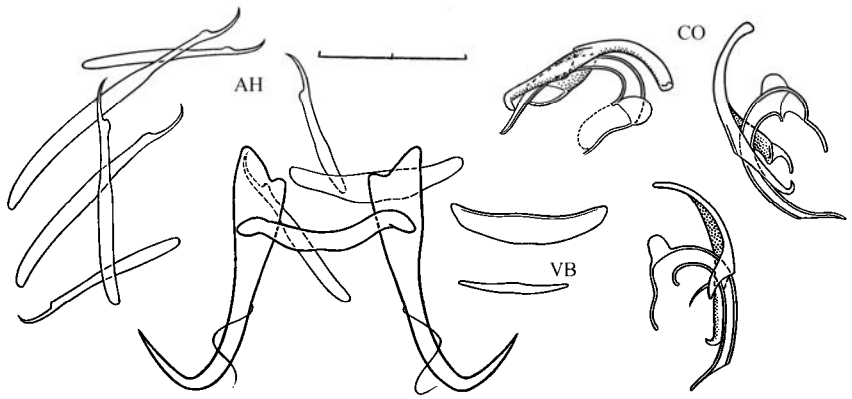
[41] Values in brackets are from the first description. There seems to be an error in the publication of Yamaguti (1942); it is written that the vas deferens turns around the right intestinal branch and that the vaginal pore is sinistral. This must be vice versa (see diagnosis of the family Dactylogyridae). The same must be changed in title of his drawings: it is a dorsal view, not a ventral view.
[42] The same type of ventral bar is present in several *Dactylogyrus* species from *Squaliobarbus curriculus*.



209



210



211

Fig. 209 – 211.
209 - *Dactylogyrus spiralis* (after Jukhimenko, 1981). **210** - *Dactylogyrus juveniformis.* **211** - *Dactylogyrus limleehongae.*

Length of marginal hooks is 0.020–0.041 mm. Length of anchors is 0.031–0.035 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.002–0.003 x 0.021–0.025 mm, ventral bar 0.002–0.005 x 0.022–0.025 mm. Copulatory tube is 0.028–0.040 mm.

Found on gill filaments of *Xenocypris macrolepis*; Liao He and Yangtze Rivers (China).

53 (52). The marginal hooks have a smooth heel of the point; the length of the anchors is greater than 0.035 mm. The accessory piece of the copulatory tube is massive and has a rectangular comb on the posterior end, a rounded comb on the anterior end, and a small finger-shaped projection in the middle.

D. primarius Gussev, 1955 (Fig. 212)

These are small worms; body can be up to 0.50 mm long and 0.10 mm wide. Length of marginal hooks is 0.027–0.041 mm. Length of anchors is equal to that of the main part, 0.036–0.055 mm, point 0.006–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.019–0.027 mm, ventral bar 0.005–0.008 x 0.020–0.029 mm. Total length of copulatory organ is 0.029–0.040 mm. Vaginal armament is poorly visible; in squeezed living specimens it is in the form of a short **V**-shaped tube.

Found on gill filaments of *Opsariichthys bidens*; basin of Amur River (Russia); Liao He and Yangtze Rivers (China).

The scale under the drawing of the anchors in Gussev (1955a) is an error: it must be 0.02 and not 0.03 mm.

54 (51). The anchors have both roots (rarely only one is present); the ventral bar is of another shape.

55 (56). The outer root of the anchors is 2.5–3 times longer than the inner one. This species is found on the gill rakers of *Hypophthalmichthys molitrix*.

D. scrjabini Akhmerov, 1954 (Fig. 213)

These are very large worms; body can be up to 2.3 mm long and 0.4 mm wide. Length of the very massive marginal hooks is 0.039–0.043 (I, III–VII pairs) mm, 0.050–0.067 mm (II pair); the handle is not almost separated from the pivot; the heel of the point is smooth. Length of the anchors: dorso-apical 0.037–0.042, ventro-apical 0.060–0.080 mm, inner root 0.010–0.015 mm, outer root 0.030–0.040 mm, point 0.007–0.010 mm. Size of dorsal bar 0.012–0.020 x 0.020–0.027 mm, ventral bar 0.010–0.012 x 0.023 mm (their shape is variable and depends on how worm has been squeezed). Both bars could be seen on slides of squeezed specimens. Length of copulatory tube is 0.060–0.075 mm, accessory piece 0.090–0.140 mm. Vaginal duct lacks a chitinoid armament.

Found on gill rakers forming a sieve of *Hypophthalmichthys molitrix*; Amur River Basin (Russia); Liao He and Yangtze Rivers (China); found in fish farms of Uzbekistan where silver carp is cultured (they are transferred there from Far East region, Russia). Surely this species is distributed in other regions where silver carp is cultured as a pond fish.

56 (55). The outer root of the anchors is shorter than the inner one (they are equal only in *D. borealis*).

57 (62). The anchors have a patch at their inner root.

58 (61). The anchors have a declinate point that is turned into the main part with a sharp bend; the ventral bar is stick-like or **T** shaped.

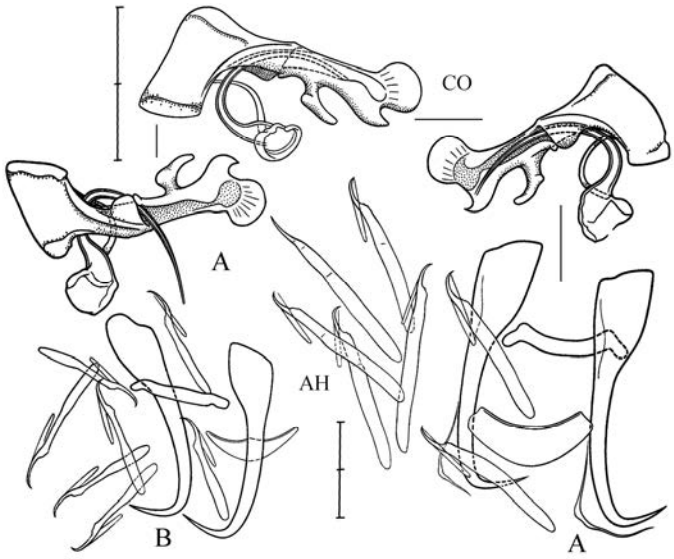
59 (60). The ventral bar is stick shaped and has a broadening in the middle. These are parasites of *Ctenopharyngodon idella*.

D. lamellatus Akhmerov, 1952 (Fig. 214)

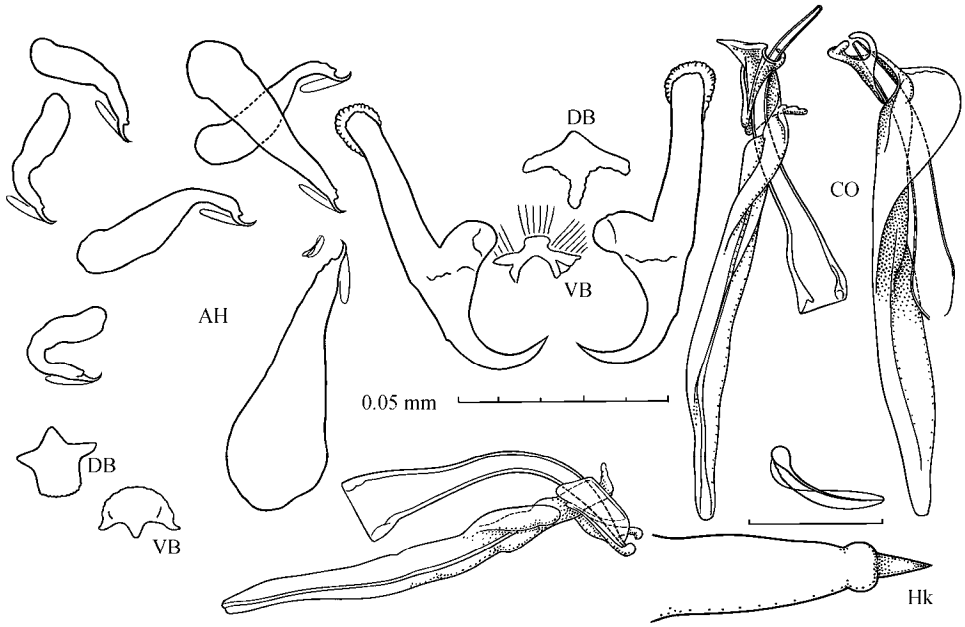
Syn.: *Scrjabinonchus lamellatus* (Akhmerov, 1952)

These are small worms; body can be up to 0.53 mm long and 0.13 mm wide. Length of marginal hooks is 0.019–0.035 mm. Length of anchors is 0.031–0.044 mm, main part 0.025–0.030 mm, inner root 0.010–0.014 mm, outer root 0.003–0.005 mm, point 0.014–0.018 mm, patch 0.006–0.010 x 0.002–0.004 mm. Size of dorsal bar is 0.002–0.005 x 0.027–0.036 mm, ventral bar 0.001–0.002 x 0.019–0.025 mm. Length of

bent copulatory tube is 0.020–0.028 mm, accessory piece 0.035–0.050 mm. Length of vaginal tube is about 0.016 mm, diameter slightly greater than 0.002 mm.



212



213

Fig. 212 – 213.

212 - *Dactylogyrus primarius*: A – adult worms, B – young specimen still without copulatory organ from the Mo River (Lake Khanka). **213 -** *Dactylogyrus scrjabini* (point of II pair of marginal hooks).

Found on gill filaments of *Ctenopharyngodon idella*; Amur River (Russia); Yangtze River (China); and everywhere this fish is now cultured.

Heavy infection of grass carp fingerlings cultured in ponds results in mortality (Bauer et Strelkov, 1963). Such a case also was observed by Molnar (1971, 1972). Fishes of 3.5–4.5 cm length had a burden up to 80–250 worms. Molnar reported that 150 or more specimens of *D. lamellatus* on one fingerling results in mortality, especially when the oxygen level is low. Methods of control are the same as for *Dactylogyrus* infection of carp, excluding the use of ammonia, which is toxic to all phytophagous fishes.

60 (59). The ventral bar is **T** shaped and has a posterior projection; the length of the latter is greater than the length of the cross arm of this bar. These are parasites of *Opsariichthys bidens.*

D. leewanweii Gussev, 1962 (Fig. 215)

These are small worms; body can be up to 0.40 mm long and 0.12 mm wide. Length of marginal hooks is 0.021–0.035 mm. Length of anchors is 0.033–0.035 mm, main part 0.025–0.029 mm, inner root 0.008–0.010 mm, outer root 0.002–0.004 mm, point 0.010–0.012 mm, patch about 0.003 x 0.002 mm. Size of dorsal bar is 0.003–0.004 x 0.021–0.023 mm, ventral bar 0.011–0.013 (with posterior projection) x 0.017–0.019 mm. Length of copulatory organ with accessory piece is 0.029–0.032 mm. Vaginal tube is absent.

Found on gill filaments of *Opsariichthys bidens*; Liao He River (China); it possibly will be found in the Amur Basin.

61 (58). The anchors have an open point that smoothly turns into the main part; the ventral bar is **T** shaped and has a posterior projection that is shorter than its cross arm. This is a parasite of *Xenocypris macrolepis*.

D. tihsiukangi Gussev, 1962 (Fig. 216)

These worms are minute; body can be up to 0.12 mm long and 0.04 mm wide. Length of marginal hooks is 0.015–0.025 mm. Length of anchors is 0.024–0.027 mm, main part 0.020–0.023 mm, inner root 0.007–0.010 mm, outer root 0.002–0.004 mm, blade 0.016–0.018 mm, patch 0.003 x 0.002 mm. Size of dorsal bar is 0.002–0.003 x 0.018–0.021 mm, ventral bar 0.004–0.007 (with projection) x 0.014–0.016 mm. Length of copulatory organ is 0.021–0.025, vaginal tube 0.023 mm, its diameter 0.002 mm.

Found on gill filaments of *Xenocypris macrolepis*; Amur (Russia) and Liao He (China) Rivers.

62 (57). The anchors lack a patch at the end of their inner root.

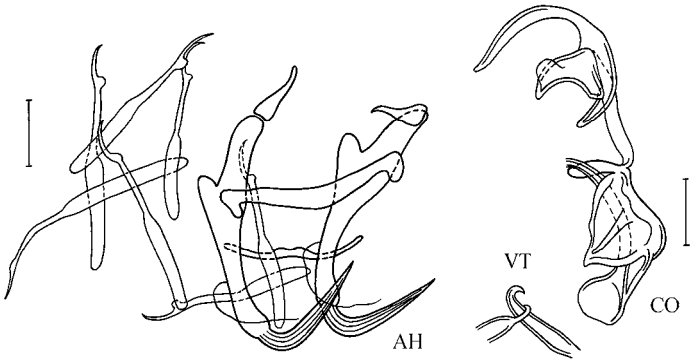
63 (76). The anchors have an open point that forms a blade with the shaft and is bent only at its tip (of the "falcatus" type).

64 (67). The dorsal bar is 1.5 times shorter than the thin stick-shaped ventral bar. This is a parasite of *Hypophthalmichthys molitrix.*

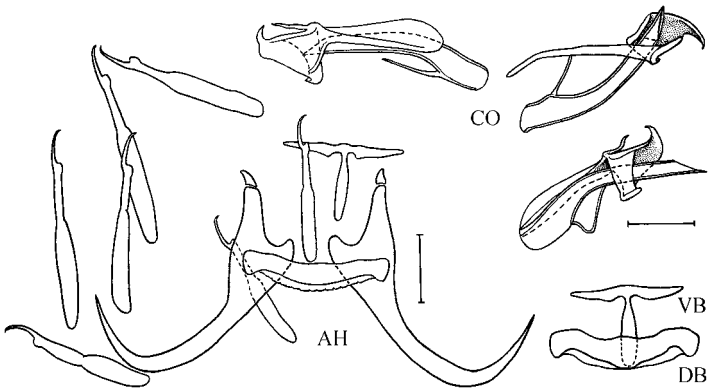
65 (66). The copulatory organ and vaginal armament are long thin tubes; the copulatory tube is twisted into a spiral with 2.5–3 spires.

D. wuhuensis Lee, 1960 (Fig. 217)

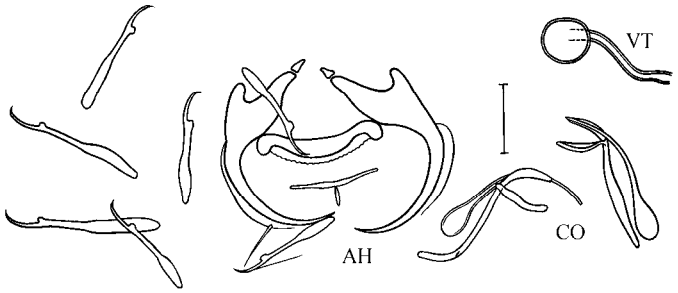
Syn.: *D. chenshuchenae* Gussev, 1962



214



215



216

Fig. 214 – 216.
214 - *Dactylogyrus lamellatus* (after Gussev, 1962). **215 -** *Dactylogyrus leewanweii* (after Gussev, 1962). **216 -** *Dactylogyrus tihsiukangi* (after Gussev, 1962).

These are small to medium size worms; body can be up to 0.64 mm long and 0.24 mm wide. Length of marginal hooks is 0.022–0.035 mm. Length of anchors: dorso-apical 0.035–0.046 mm, ventro-apical 0.037–0.048 mm, main part 0.034–0.044 mm, inner root 0.007–0.012 mm, outer root 0.003–0.006 mm, blade 0.028–0.032 mm. Size of dorsal bar is 0.003–0.006 x 0.024–0.033 mm, ventral bar 0.002–0.003 x 0.031–0.047 mm. Length of copulatory tube along the curve is 0.155–0.185 mm, vaginal tube 0.13–0.15 mm.

Found on gill filaments of *Hypophthalmichthys molitrix*; Amur (Russia), Liao He, and Yangtze (China) Rivers. Found also in the Amudar'ya River where silver carp has been established.

66 (65). The copulatory organ has a thin sickle-shaped short tube; the vaginal armament is in the form of a small mushroom.

D. suchengtaii Gussev, 1962 (Fig. 218)

These are small worms; body can be up to 0.30 mm long and 0.08 mm wide. Length of marginal hooks is 0.019–0.037 mm. Length of anchors: dorso-apical 0.032–0.038 mm, ventro-apical 0.037–0.046 mm, main part 0.034–0.038 mm, inner root 0.006–0.011 mm, blade 0.028–0.031 mm. Size of dorsal bar is 0.004–0.006 x 0.020–0.023 mm, ventral bar 0.001–0.003 x 0.028–0.044 mm. Length of copulatory organ is 0.020–0.027 mm.

Found on gill filaments of *Hypophthalmichthys molitrix*; Amur (Russia) and Liao He (China) Rivers; found in Amudar'ya where this fish is established.

67 (64). The dorsal bar is longer than the stick-shaped or **T**-shaped ventral bar. These are parasites of different fishes.

68 (71). The copulatory tube is long (greater than 0.085 mm) and thin; the diameter in its middle is more than 30 times smaller than its length.

69 (70). The copulatory tube forms a spiral; its accessory piece resembles a wing-shaped plate that surrounds the tube. The ventral bar is minute and **T** shaped; its width is about 1/3 that of the dorsal bar.

D. curvicirrus Akhmerov, 1952 (Fig. 219)

These are medium size or large worms; body can be up to 1.0 mm long and 0.16 mm wide. Length of marginal hooks is 0.030–0.049 mm. Length of anchors: dorso-apical 0.045–0.056 mm, ventro-apical 0.050–0.062, main part 0.044–0.055 mm, inner root 0.009–0.013 mm, outer root 0.005–0.008 mm, blade 0.036–0.042 mm. Size of dorsal bar is 0.006–0.014 x 0.035–0.046 mm, ventral bar 0.003–0.004 x 0.008–0.016 mm. Copulatory tube is 0.11–0.16 mm. Vaginal armament is represented by a bubble-shaped seminal receptacle with a diameter of 0.020–0.040 mm and a tube length is 0.028–0.031 mm.

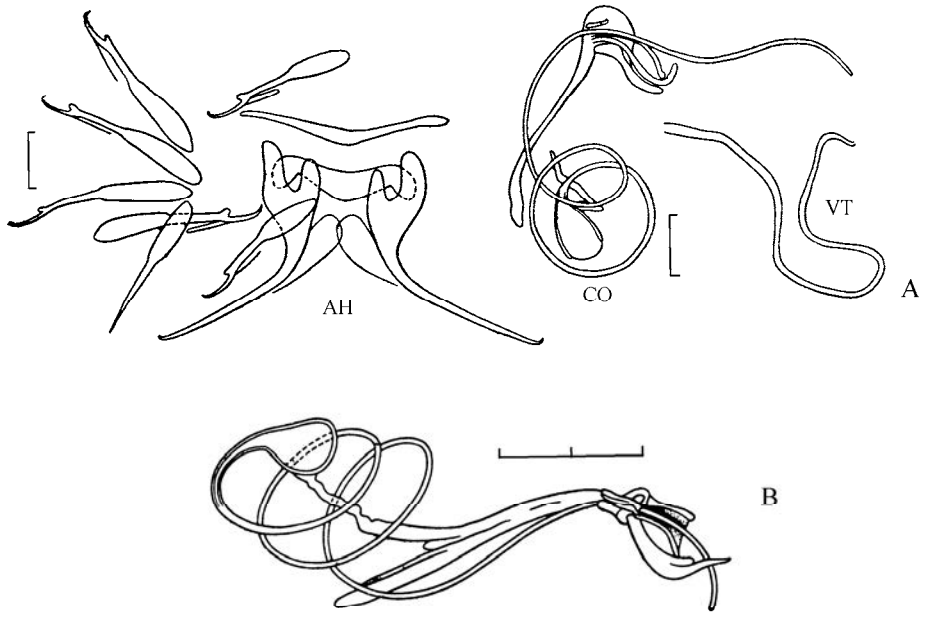
Found on gill filaments of *Culter alburnus*; Amur River, Lake Khanka (Russia); Liao He and Yangtze Rivers (China).

70 (69). The copulatory tube is very thin and **S** shaped; its accessory piece resembles a plate in the form of a blossoming flower. The ventral bar is stick shaped; its width can be up to 3/5 that of the dorsal bar.

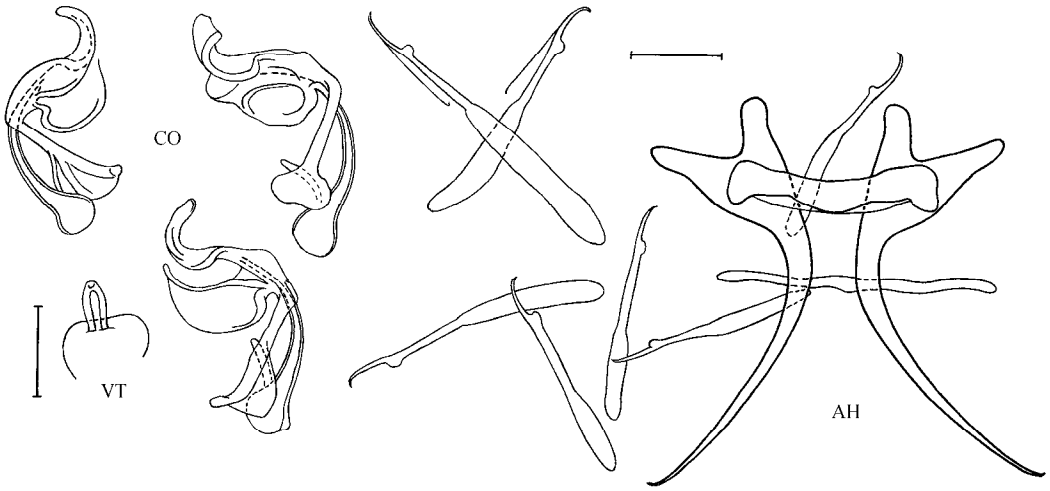
D. palliatus Gussev, 1955 (Fig. 220)

These are small worms; body can be up to 0.35 mm long and 0.1 mm wide. Length of marginal hooks is 0.022–0.036 mm. Length of anchors: dorso-apical 0.035–0.043 mm, ventro-apical 0.040–0.046 mm, main part 0.036–0.041 mm, inner root 0.013–0.018 mm, outer root 0.002–0.003 mm, blade 0.029–0.031 mm. The anchors of this species have a poorly visible bend between the point and shaft that has not been observed in the "falcatus" type. Size of dorsal bar is 0.005–0.007 x 0.036–0.041 mm, ventral bar 0.001–0.002 x 0.023 mm. Length of copulatory organ is 0.087–0.097 mm. Vaginal armament is absent.

Found on gill filaments of *Parabramis pekinensis* and *Megalobrama skolkovii*; basin of Amur River (Russia); Yangtze River (China).



217



218

Fig. 217 – 218.
217 - *Dactylogyrus wuhuensis*: A – from Liao He River, China (after Gussev, 1962); B – from Yangtze River, China (after Chen et al., 1973). **218 -** *Dactylogyrus suchengtaii* (after Gussev, 1962).

71 (68). The copulatory tube is rather short (less than 0.050 mm) and broad; the diameter in its middle part is less than 15 times shorter than its length.

72 (75). The ventral bar is **T** shaped and about half the width of the dorsal bar; the marginal hooks are equal to or slightly shorter than the anchors (no more than on 1/5 shorter).

73 (74). The copulatory tube is wide, with a diameter of about 0.004 mm in the middle part, and sickle shaped; the accessory piece is in the form of a ring-shaped muff that surrounds the tube.
D. vaginulatus Tschang et Niu, 1966 (Fig. 221)

These are large worms; body can be up to 1.6 mm long and 0.2 mm wide. Length of marginal hooks is 0.039–0.057 mm. Length of anchors: dorso-apical 0.030–0.045 mm, ventro-apical 0.040–0.050 mm, main part 0.030–0.045 mm, inner root 0.010–0.014 mm, outer root 0.007–0.009 mm, blade 0.032 mm. Size of dorsal bar is 0.005–0.006 x 0.031–0.034 mm, ventral bar 0.005–0.007 x 0.019–0.022 mm. Total length of copulatory organ is 0.040–0.045 mm. Vaginal armament is absent.

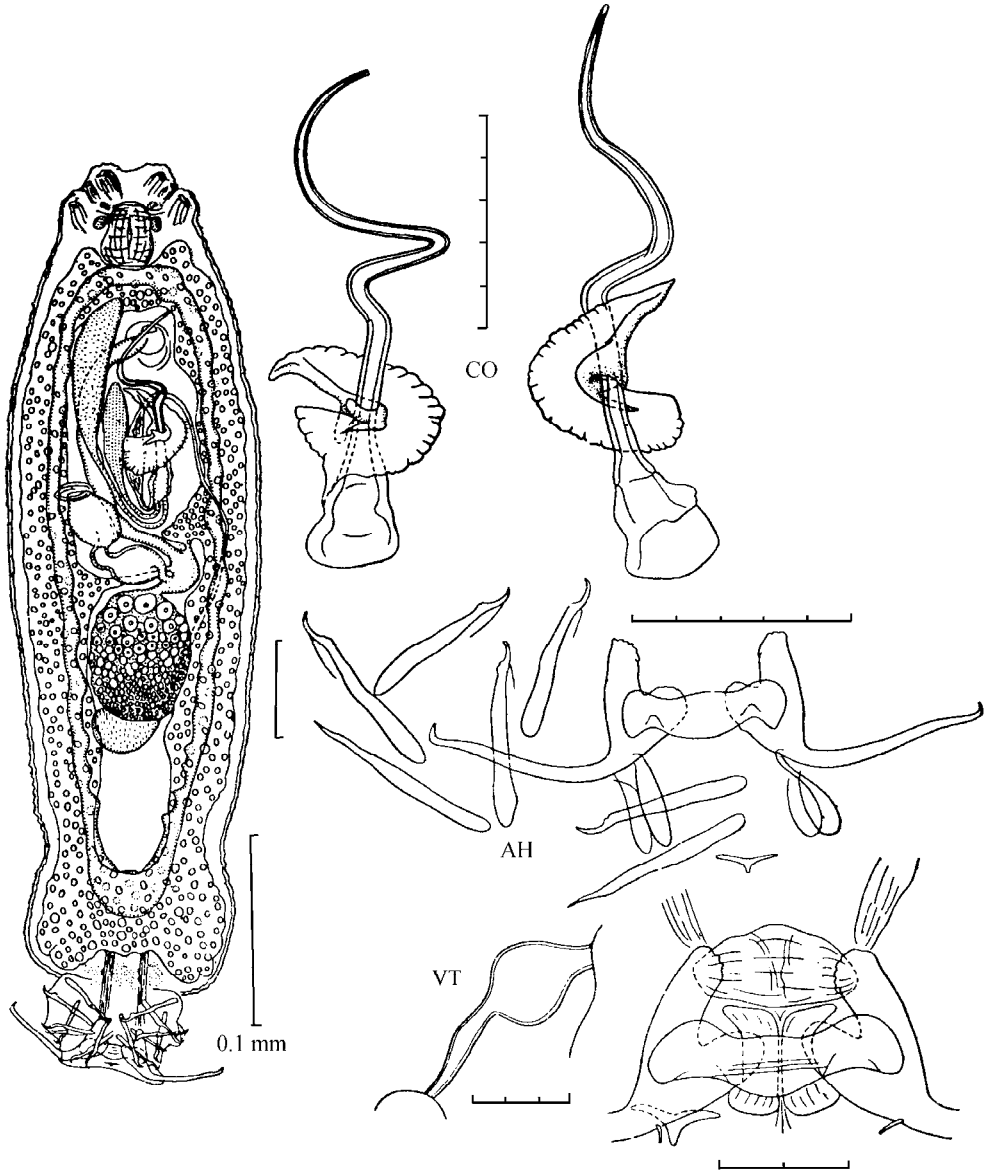
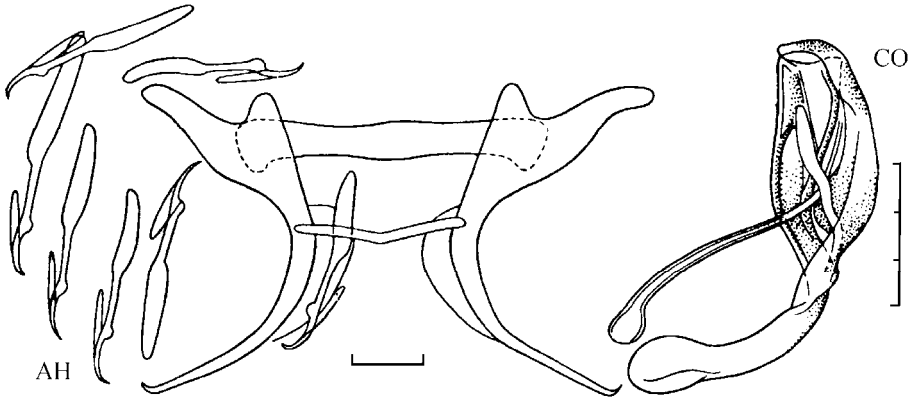
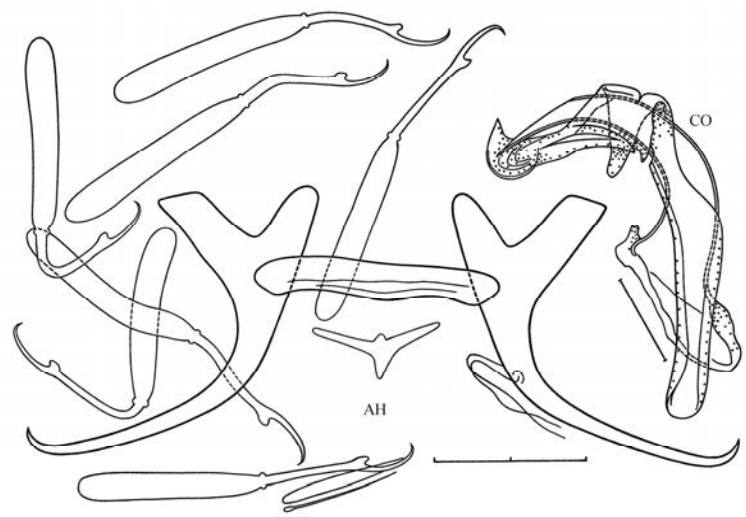


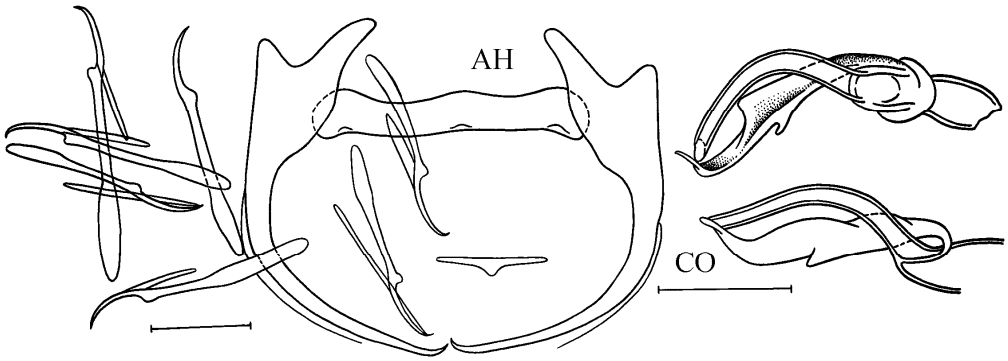
Fig. 219 - *Dactylogyrus curvicirrus*, total drawing from ventral view (after Gussev, 1955a).



220



221



222

Fig. 220 – 222.
220 - *Dactylogyrus palliatus* (after Gussev, 1955a). **221 -** *Dactylogyrus vaginulatus* (after Jukhimenko, 1981). **222 -** *Dactylogyrus peculiaris* (after Gussev, 1955a).

Found on gill filaments of *Hypophthalmichthys molitrix*; Amur (Russia) and Yangtze (China) Rivers. It also has been found on *Aristhichthys nobilis* and *Ctenopharhyngodon idella* in fish farms of North Caucasus (Russia).

74 (73). The diameter of the copulatory tube in its middle is about 0.002 mm; it is arch shaped; its accessory piece forms a gutter with a pointed end.
D. peculiaris Gussev, 1955 (Fig. 222)

These are small worms; body can be up to 0.4 mm long and 0.13 mm wide. Length of marginal hooks is 0.018–0.029 mm. Length of anchors: dorso-apical 0.030–0.034 mm, ventro-apical 0.033–0.037 mm, main part 0.028–0.032 mm, inner root 0.006–0.009 mm, outer root 0.003–0.004 mm, blade about 0.025 mm. Size of dorsal bar is 0.002–0.004 x 0.028–0.037 mm, ventral bar 0.002 x 0.012–0.013 (0.019–0.020)[43] mm. Total length of copulatory organ is 0.019–0.025 mm. Vaginal armament is absent.

Found on gill filaments of *Hemiculter leucisculus* and *H. lucidus*; Amur River, Lake Khanka (Russia); Liao He and Yangtze Rivers (China).

75 (72). The ventral bar is cap shaped and is visible only in well-pressed specimens; the length of the marginal hooks is less than 2/3 that of the anchors.
D. slastnikowi Gussev, 1955 (Fig. 223)

These are small worms; body can be up to 0.4 mm long and 0.06 mm wide. Length of marginal hooks is 0.021–0.029 mm. Length of anchors is 0.042–0.051 mm (dorso-apical and ventro-apical length is the same), main part 0.040–0.046 mm, inner root 0.008–0.012 mm, outer root about 0.002 mm, blade 0.039–0.042 mm. Size of dorsal bar is 0.006–0.007 x 0.049–0.052 mm, ventral bar about 0.002–0.003 x 0.006 mm. Total length of copulatory organ is about 0.025 mm. Vaginal armament is absent.

Found on gill filaments of *Plagiognathops microlepis* and *Xenocypris macrolepis*; Amur River Basin (Russia).

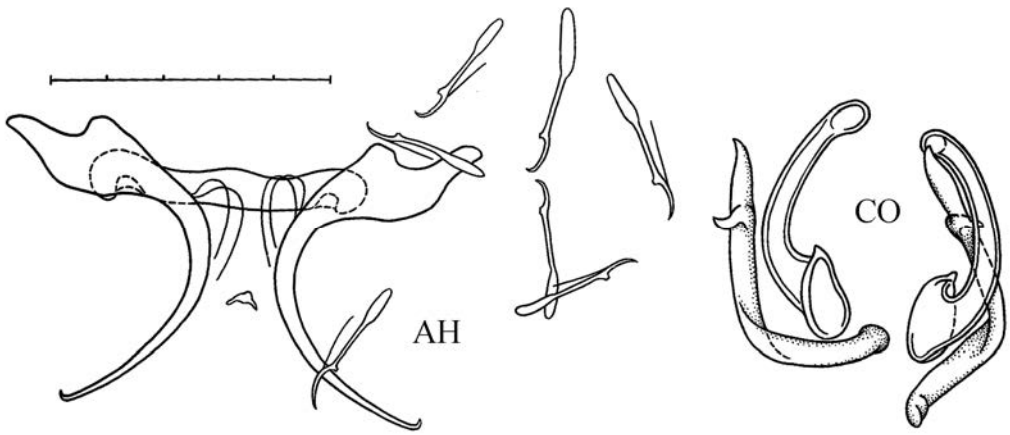


Fig. 223 - *Dactylogyrus slastnikowi* (after Gussev, 1955a).

76 (63). The anchors have a declinate point that turns into a shaft with a more or less well visible bend (other types of anchors).

[43] Data in brackets are from Chen et al. (1973).

77 (82). The haptor and attachment manner to gills are of the "sphyrna" type; one pair of marginal hooks (the third one?) is longer and thicker than the others; its point is directed to the points of the anchors; anchors are of the "sphyrna" type but slightly different (roots are shorter).

78 (79). The main part of the anchors has a massive outgrowth on the inside before it turns into a point.
D. falciunguis (Akhmerov, 1952) (Fig. 224)
Syn.: *Falciunguis parabramis* Akhmerov, 1952

These are large or medium size worms; body can be up to 1.4 mm long and 0.33 mm wide. Length of III pair of marginal hooks is 0.040–0.048 mm, others 0.020–0.027 mm. Length of anchors is 0.042–0.052 mm, main part 0.039–0.042 mm, inner root 0.013–0.018 mm, outer root 0.005–0.009 mm, point 0.010–0.013 mm. Size of **T**-shaped dorsal bar is 0.008–0.012 x 0.025–0.035 mm, ventral bar 0.001–0.002 x 0.011–0.016 mm. Length of copulatory organ is 0.035–0.047 mm. Vaginal armament is absent.

Found on gill filaments of *Parabramis pekinensis*; Amur River Basin (Russia); Yangtze River (China).

79 (78). The main part of the anchors lacks outgrowths and bulges.

80 (81). The outer root of the anchors is very short; the third pair of marginal hooks is nearly twice as long as the others. The copulatory tube is **S** shaped and relatively long and narrow.
D. sparsus Gussev, 1955 (Fig. 225)

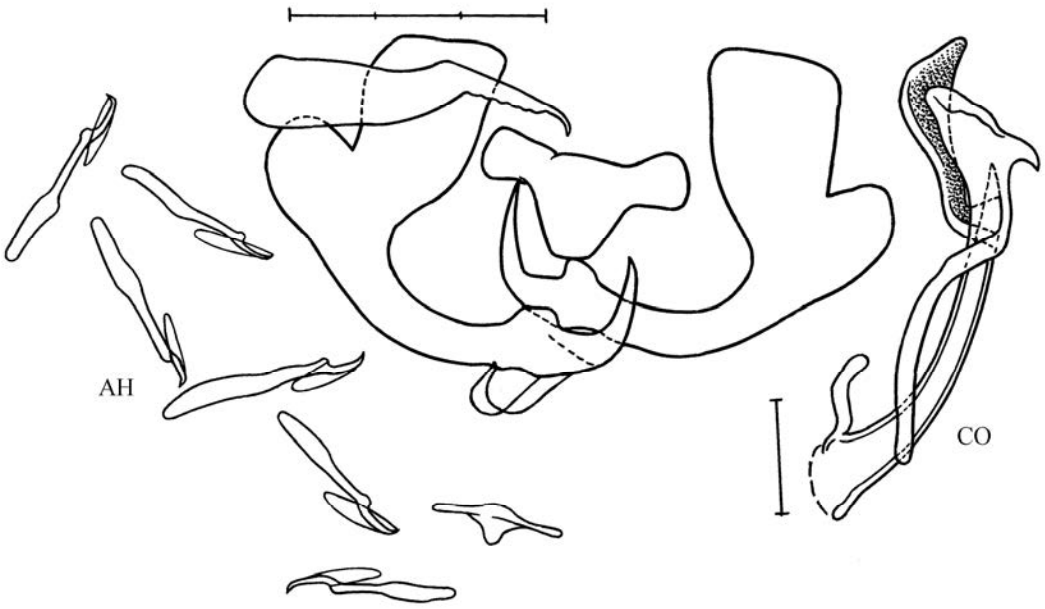


Fig. 224 - *Dactylogyrus falciunguis* (after Gussev, 1955a).

These are small worms; body length can be up to 0.35 mm, width 0.09 mm. Length of III pair of marginal hooks is 0.031–0.044 mm, others 0.017–0.024 mm. Length of anchors is 0.041–0.053 mm, main part 0.039–0.049 mm, inner root 0.011–0.016 mm, outer root less than 0.002 mm, point 0.011–0.012 mm. Size of the curious saddle-shaped dorsal bar is 0.003–0.007 x 0.020–0.022

mm, stick-shaped ventral bar about 0.003 x 0.016 mm. Total length of copulatory organ is 0.029–0.037 mm. Vaginal armament is curved with a broadening in the middle part of the tube, length about 0.050 mm.

Found on gill filaments of *Microphysogobio tungtingensis*; Amur River Basin (Russia).

81 (80). The outer root of the anchors is well developed; the III pair of marginal hooks is only 1.2–1.3 times longer than the longest of the others. The copulatory tube is nearly straight and relatively short and broad.

D. alatoideus Gussev, 1955 (Fig. 226, 227)[44]

Syn.: *D. alaeonchus* Akhmerov, 1965

These are small worms; body length can be up to 0.40 mm, width 0.12 mm. Length of III pair of marginal hooks is about 0.035 (0.034–0.036) mm, others 0.019–0.022 (0.018–0.024) mm. Length of anchors is 0.031–0.035 mm, main part 0.025–0.026 mm, inner root 0.012–0.015 (0.017–0.020) mm, outer root 0.005–0.006 mm, point 0.012–0.013 (0.013–0.016) mm. Size of dorsal bar is 0.005–0.008 x 0.021–0.028 mm, **T**-shaped ventral bar 0.013 x 0.014 (0.007 x 0.014) mm. Length of copulatory organ is 0.021–0.028 mm. Vaginal armament is absent.

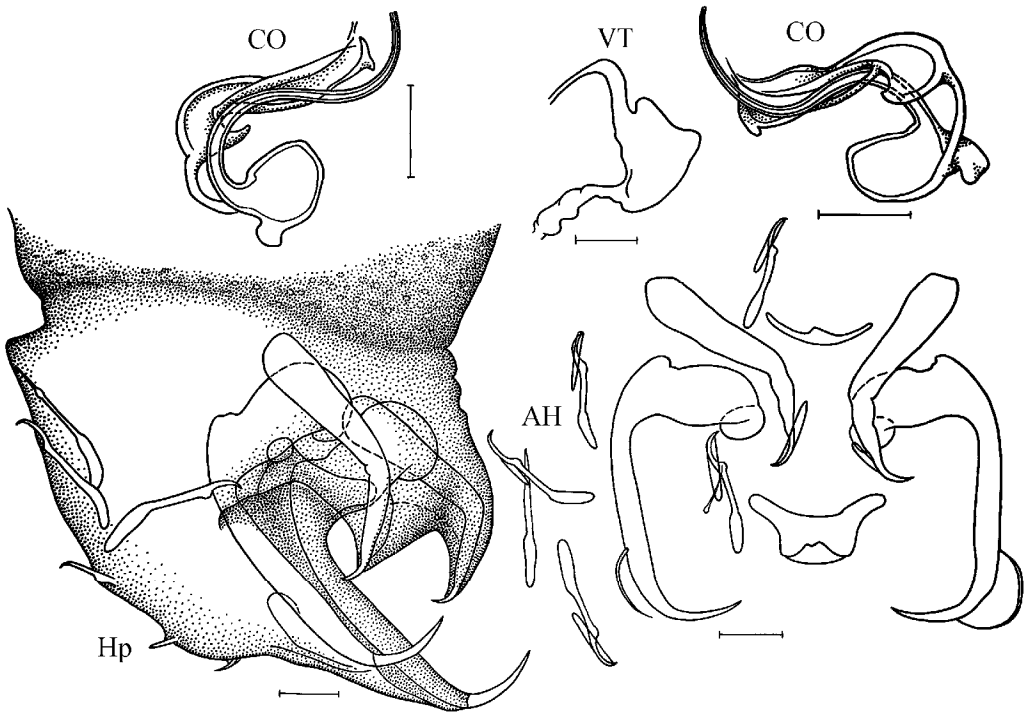


Fig. 225 - *Dactylogyrus sparsus* (after Gussev, 1955a).

[44] Measurements and shape of chitinoid structures of specimens from *Xenocypris* used to describe the new species *D. alaeonchus* are very similar (they are given in brackets) to data for specimens from *Hemiculter*. This is why we think there is only one species.

Found on gill filaments of *Hemiculter leucisculus* and *Xenocypris macrolepis* (?); Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

82 (77). The haptor and attachment manner to gills are of the "wunderi" type (in *D. facetus* only the latter is of the "anchoratus" one?); anchors vary in size and shape; marginal hooks of different pairs are usually only slightly variable in length and thickness.

83 (84). The anchors are large: greater than 0.085 mm and more than four times longer than the marginal hooks; their inner root and point are 1.5–2 times longer than the marginal hooks.
D. magnihamatus Akhmerov, 1952 (Fig. 228)

These are medium size or large worms; body can be up to 1.0 mm long and 0.18 mm wide Length of marginal hooks is 0.020–0.030 (up to 0.037)[45] mm. Length of anchors is 0.085–0.136 mm, main part 0.062–0.092 mm, inner root 0.041–0.066 (up to 0.077) mm, outer root 0.007–0.020 (up to 0.027) mm, point 0.030–0.055 mm. Size of dorsal bar is 0.006–0.010 x 0.045–0.070 (up to 0.090?) mm, ventral bar 0.001–0.002 x 0.019–0.024 mm. Length of copulatory tube is 0.048 (0.030) –0.066 mm. Vaginal armament is absent.

Found on gill filaments of many fishes of Amur River (Russia) and Chinese rivers: *Hypophthalmichthys molitrix*, *Ctenopharhyngodon idella*, *Mylopharyngodon piceus*, *Parabramis pekinensis*, *Megalobrama skolkovii*, *Culter alburnus*, *Chanodichthys mongolicus*, *C. erythropterus*, *Hemiculter leucisculus*, *Opsariichthys bidens*, *Elopichthys bambusa*, *Squaliobarbus curriculus*, Amudar'ya (Central Asia, transferred with fish stocks); water bodies of China and Vietnam. It is found in large quantities on young grass carps in fish farms of China and Vietnam, resulting disease and even mortality.

84 (83). The anchors are less than 0.065 mm (less than three times longer than the marginal hooks); their inner root and point are shorter (in most cases much shorter) than the marginal hooks.

85 (88). The declinate point of the anchors has an end that is recurved outside (like an ox horn).

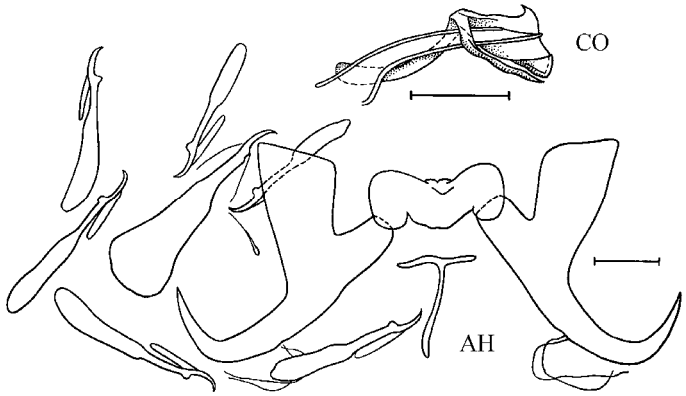
86 (87). The marginal hooks are less than two times shorter than the anchors but not less than two times longer than the length of the inner root and point; they are situated as usual on the level of the anchors.
D. squameus Gussev, 1955 (Fig. 229)

These are small worms; body can be up to 0.4 mm long and 0.09 mm wide. Length of thin marginal hooks with a protruded heel of the point is 0.017–0.030 mm. Length of anchors is 0.037–0.040 (ventro-apical, dorso-apical length is slightly shorter), main part 0.031–0.034 mm, inner root 0.007–0.009 mm, outer root 0.004–0.006 mm, point 0.008–0.010 mm. Size of dorsal bar is 0.005–0.006 x 0.023–0.025 mm, ventral bar 0.001–0.002 x 0.023–0.025 mm. Length of copulatory organ is 0.021–0.024 mm. Vaginal armament is absent.

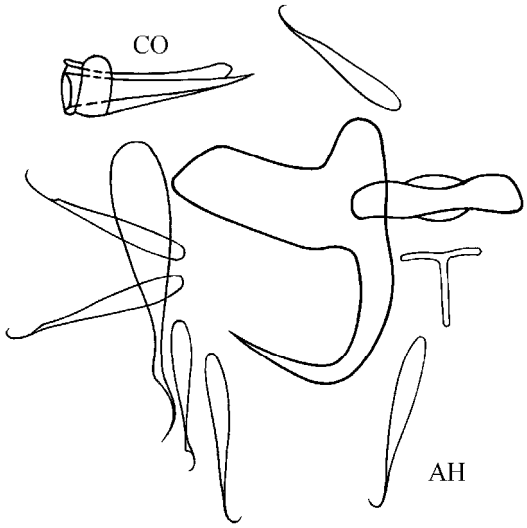
Found on gill filaments of *Pseudorasbora parva*; Amur River Basin (Russia); Liao He River (China). It has been transferred occasionally with its host to other localities and now is found in many water bodies of Central Asia, Ukraine, and other regions.

87 (86). The marginal hooks are three times shorter than the anchors but less than 1.5 times greater than the length of the inner root and its point; hooks are situated in the upper part of the haptor forward of the anchors.
D. maximus Gussev, 1955 (Fig. 230)

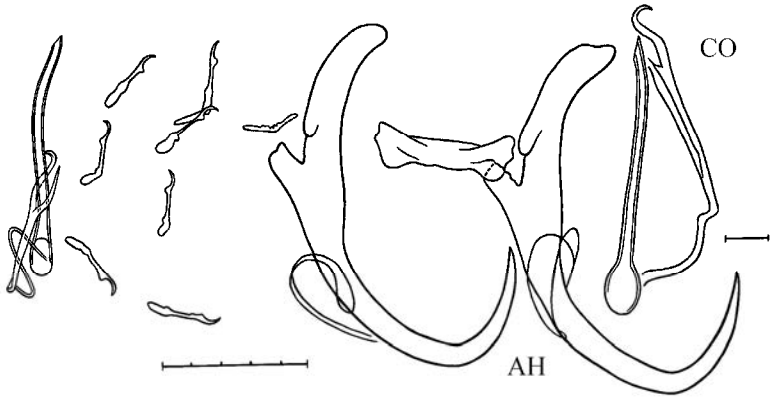
[45] Data in brackets are from Chen et al. (1973).



226

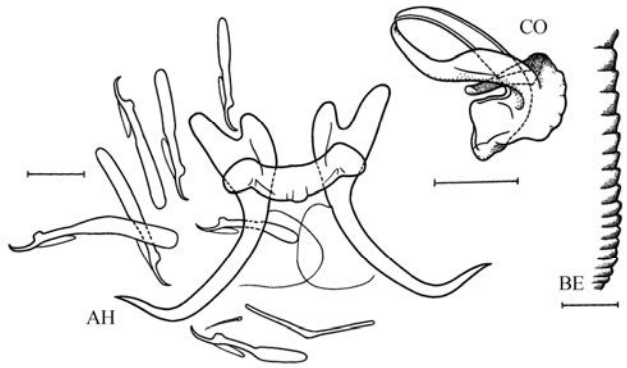


227

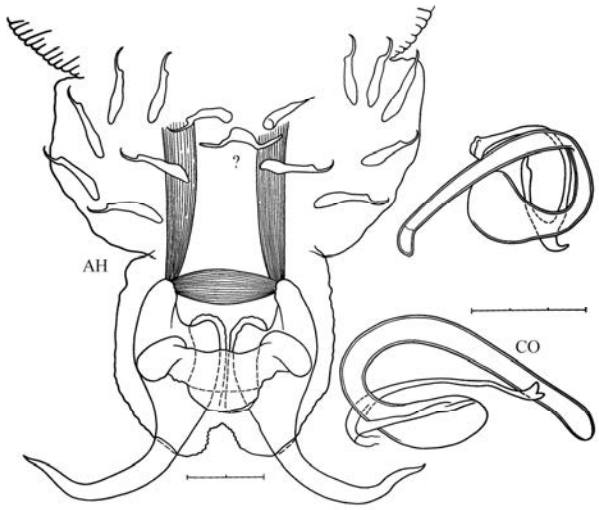


228

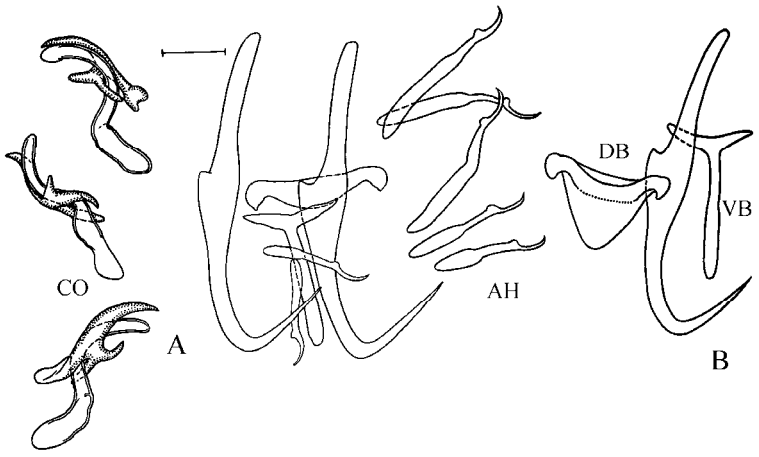
Fig. 226 – 228.
226 - *Dactylogyrus alatoideus* (after Gussev, 1955a). **227 -** *Dactylogyrus "alaeonchus*" (after Akhmerov, 1965). **228 -** *Dactylogyrus magnihamatus* (after Gussev, 1955a).



229

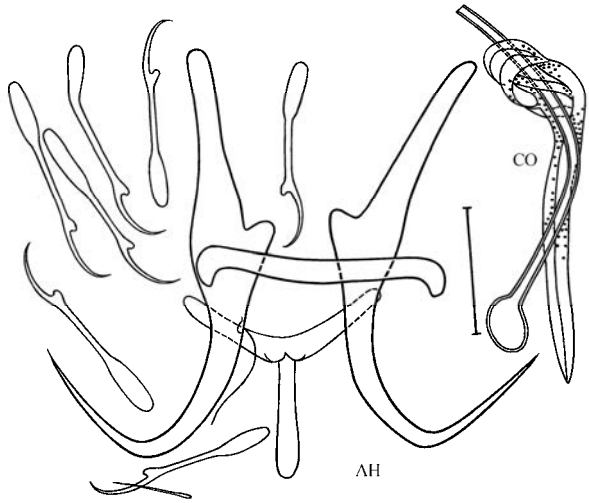


230

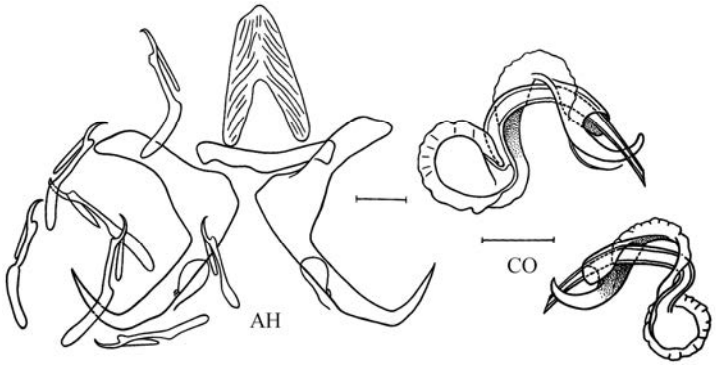


231

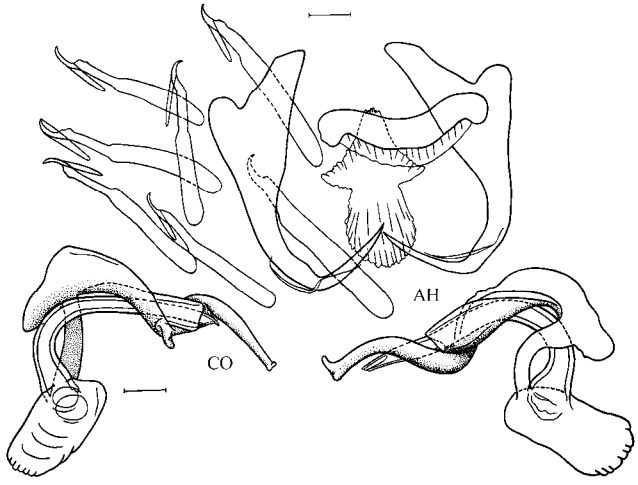
Fig. 229 – 231.
229 - *Dactylogyrus squameus* (after Gussev, 1955a). **230 -** *Dactylogyrus maximus* (after Gussev, 1955a). **231 -** *Dactylogyrus xenocypris*: A – specimen from Liao He River (China), B – specimen from Amur River (Russia) (both after Gussev, 1962).



232



233



234

Fig. 232 – 234.
232 - *Dactylogyrus chernyshevae* (after Jukhimenko, 1981). **233 -** *Dactylogyrus facetus* (after Gussev, 1955a). **234 -** *Dactylogyrus markewitschi* (after Gussev, 1955a).

These are large worms; body can be up to 1.11 mm long and 0.20 mm wide. Marginal hooks are rough in form; their handle is poorly bordered from the pivot and lacks a protruded heel. Length of marginal hooks is 0.016–0.021 mm. Length of massive anchors is 0.055–0.062 mm, main part 0.049–0.052 mm, inner root 0.009–0.012 mm, outer root 0.003–0.004 mm, point about 0.014 mm. Size of dorsal bar is 0.011–0.015 x 0.039–0.045 mm, ventral bar (poorly visible on slides) 0.001–0.003 x 0.020 mm. Length of copulatory organ, which has a sickle-shaped and wide tube, is 0.053–0.068 mm, tube along the curve 0.097–0.111, diameter in middle 0.005–0.006 mm. Vaginal armament is absent.

Found on gill filaments of *Sarcocheilichthys czerskii*; Amur River Basin (Russia).

88 (85). The declinate point is nearly straight; it sometimes is bent but never is recurved outside.

89 (92). The anchors have a relatively long inner root (its length is 4/5 the length of the main part); the outer root is very short (its length is less than 1/10 the length of the inner root); anchors are of the "wegeneri" type (see Fig. 5, 11). These are parasites of *Xenocypris*.

90 (91). The width of the dorsal bar is less than a half of the anchor length and is equal to the length of its inner root.

D. xenocypris Akhmerov, 1952 (Fig. 231)

These are small worms; body can be up to 0.37 mm long and 0.06 mm wide. Length of marginal hooks is 0.018–0.030 mm. Length of anchors is 0.048–0.052 mm, main part 0.028–0.029 mm, inner root 0.019–0.024 mm, outer root less than 0.0025 mm, point 0.015–0.016 mm. Size of dorsal bar is 0.003 x 0.019–0.023 mm, ventral **T**-shaped bar 0.021–0.023 (with projection) x 0.014–0.015 mm. Length of copulatory organ, which has a short broad sickle-shaped tube, is 0.030–0.033 mm. Vaginal armament is absent.

Found on gill filaments of *Xenocypris macrolepis*; Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

91 (90). The width of the dorsal bar is not less than 2/3 of the anchor length and is longer than its inner roots.

D. chernyshevae Jukhimenko, 1981 (Fig. 232)

These are small worms; body can be up to 0.3 mm long and 0.08 mm wide. Length of marginal hooks is 0.014–0.021 mm. Length of anchors is 0.027–0.035 mm, main part 0.015–0.020 mm, inner root 0.012–0.016 mm, outer root 0.005–0.013 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.003–0.004 x 0.016–0.020 mm, ventral **T**-shaped bar 0.011–0.014 (with projections) x 0.014–0.016 mm. Length of copulatory organ, which has an arched-shaped cylindrical tube, is 0.027–0.033 mm. Vaginal armament is absent.

Found on gill filaments of *Xenocypris macrolepis*; Amur River near Khabarovsk (Russia).

92 (89). The anchors have a relatively short inner root, which in most cases is not longer than half (in rare cases 2/3) the length of the main part; the outer root in most cases is easily visible; anchors are of the "wunderi" or other types. These are parasites of different fishes.

93 (98). The ventral bar is **V**, **+,** or **Λ** shaped. These are parasites of Acheilognathinae and Gobioninae.

94 (95). The ventral bar is **V** shaped; marginal hooks of the second pair differ from the others by having a blade and heel that is almost two times longer. The copulatory organ has a long flagellate bent tube. This is a parasite of Acheilognathinae.

D. bicornis Malewizkaja, 1941 (Fig. 51)

95 (94). The dorsal bar is **Λ** or **+** shaped; the marginal hooks of all pairs are the same shape, but handle length may vary. The copulatory organ is of the "cryptomeres" type. These are parasites of

Gobioninae.

96 (97). The dorsal bar is **Λ** shaped; the outer root of the anchors poorly visible; the inner one departs from the main part of the axis by less than 90°; the anchors are ⊂ shaped. The attachment manner to gills is probably of the "anchoratus" type.

D. facetus Gussev, 1955 (Fig. 233)

These are small worms; body can be up to 0.4 mm long and 0.10 mm wide. Length of marginal hooks is 0.019–0.029 mm. Length of anchors is 0.030–0.039 mm, main part 0.029–0.036 mm, inner root 0.012–0.017 mm, outer root less than 0.002 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.003–0.004 x 0.023–0.027 mm, ventral bar (of fibrous structure) 0.024–0.035 x 0.013–0.017 (width between posterior branches) mm. Length of copulatory is organ 0.025–0.032 mm. Vaginal armament is absent.

Found on gill filaments of *Abbottina rivularis* and *Saurogobio dabryi*; Amur River Basin (Russia).

97 (96). The ventral bar resembles a cross-shaped shield with broad projections; the outer root of the anchors is well developed; the angle between it and the inner root usually is acute. The attachment manner to gills is of the "wunderi" type.

D. markewitschi Gussev, 1955 (Fig. 234)

These are medium or large size worms; body can be up to 0.9 mm long and 0.17 mm wide. Marginal hooks have a smooth heel and length is 0.033–0.058 mm. Length of anchors is 0.044–0.061 mm, main part 0.035–0.051 mm, inner root 0.012–0.020 mm, outer root 0.004–0.006 mm, point 0.015–0.025 mm. Size of dorsal bar is 0.006–0.010 x 0.035–0.053 mm, ventral bar (of fibrous structure) 0.039–0.053 x 0.025–0.031 mm. Length of copulatory organ is 0.066–0.082 mm. Vaginal armament is absent.

Found on gill filaments of *Abbottina rivularis* and *Saurogobio dabryi*; basin of Amur River (Russia); Liao He River (China).

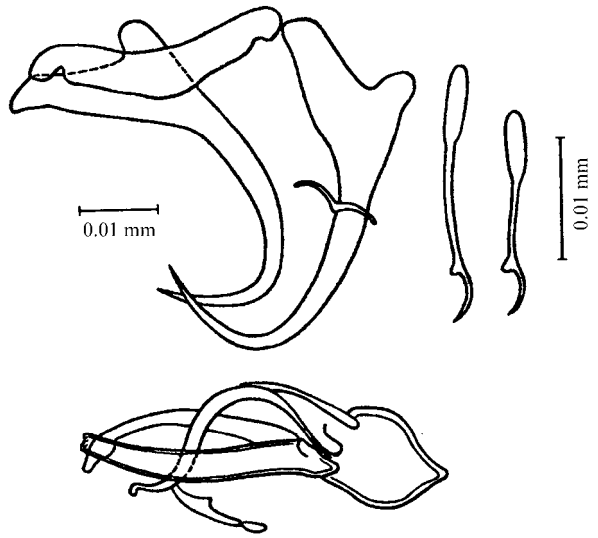


Fig. 235 - *Dactylogyrus tonii* (after Ermolenko, 2003).

98 (93). The ventral bar is of another shape. These are parasites of different fishes.

99 (151). The ventral bar resembles a transverse stick, in most cases thickened at its middle, and is bent forward or backward (sometimes **V** shaped or like a transverse brace) but lacks an easily visible projection.

100 (101). The copulatory organ is of the original type and has a large dilation of the initial part of the tube.

D. tonii Ermolenko, 2003 (Fig. 235)

These are medium size worms; body can be up to 0.6 mm long. Length of marginal hooks 0.017–0.039 mm. Length of anchors is 0.043–0.055 mm, main part 0.035–0.049 mm, outer root 0.005–0.007 mm, inner root 0.013–0.014 mm, point 0.012–0.013 mm. Size of dorsal bar is 0.006–0.008 x 0.033 mm, ventral bar 0.001 x 0.011 mm. Length of copulatory organ is 0.054–0.055 mm, tube width 0.003–0.005 mm. Vaginal armament is absent.

Found on gills of *Barbatula toni;* Edinka and Komissarovka Rivers (southern Maritime Territory, Russia).

101 (112). The copulatory organ is of the "cryptomeres" or "navicularis" types. These are parasites of Gobioninae.

102 (109). The copulatory organ is of the “cryptomeres” type; the initial part of the tube has a supporting projection.

103 (106). The supporting projection of the initial part of the copulatory tube is small (less than the diameter of the tube); the copulatory organ is rather small (less than 0.03 mm). These are parasites of *Abbottina revularis* and *Saurogobio dabryi*.[46]

104 (105). The marginal hooks have a handle that is well separated from the pivot and the point’s heel is protruded; the length of the hooks is less than 0.04 mm; the inner root of the anchors is long, often with parallel edges; it five to six times longer than the outer one.

D. pseudogobii Akhmerov, 1952 (Fig. 236)

These are small or medium size parasites; body can be up to 0.60 mm long and 0.12 mm wide. Length of marginal hooks is 0.025–0.026 mm. Length of anchors is 0.043–0.049 mm, main part 0.035–0.041 mm, inner root 0.012–0.020 mm, outer root 0.002–0.004 mm, point 0.008–0.012 mm. Size of dorsal bar is 0.004–0.006 x 0.023–0.027 mm, ventral bar 0.002 x 0.023–0.025 mm. Total length of copulatory organ is 0.021–0.029, tube 0.024–0.037 mm. Vaginal armament is absent.

Found on gill filaments of *Abbottina revularis* and *Saurogobio dabryi*; Amur River Basin (Russia); Liao He River (China).

105 (104). The marginal hooks are rather rough; the heel is smoothed; length can be up to 0.058 mm; the inner root of the anchors is short and tapers to its end; the inner root is longer than outer root (less than three times).

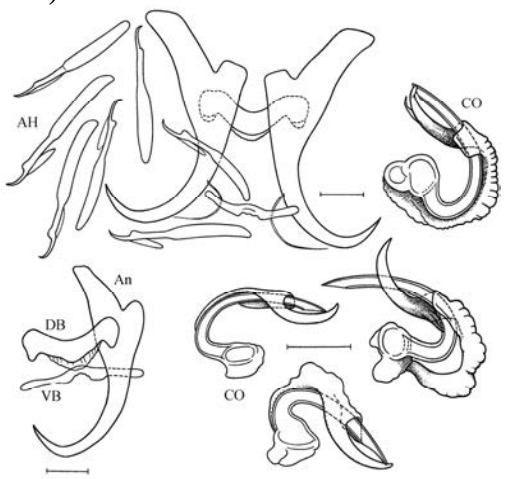
D. gobioninum Gussev, 1955 (Fig. 237)

These are minute worms; body can be up to 0.33 mm long and 0.12 mm wide. Length of marginal hooks is 0.029–0.058 (the II pair is longest) mm. Length of anchors is 0.037–0.054 mm, main part 0.033–0.045 mm, inner root 0.006–0.010 mm, outer root 0.002–0.004 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.003–0.005 x 0.023–0.037 mm, ventral bar 0.002–0.004 x 0.020–0.025 mm. Length of copulatory organ is 0.021–0.029 mm, length of tube along the curve 0.029–0.033 mm. Vaginal armament is absent.

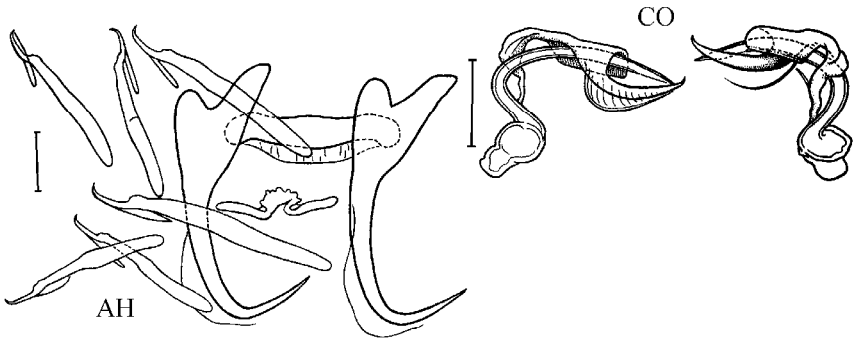
Found on gill filaments of *Abbottina rivularis* and *Saurogobio dubryi*; Amur River Basin

[46] See *D. guizhouensis* Long et Tao, 1982 and *D. guangxiensis* Long et Tao, 1982.

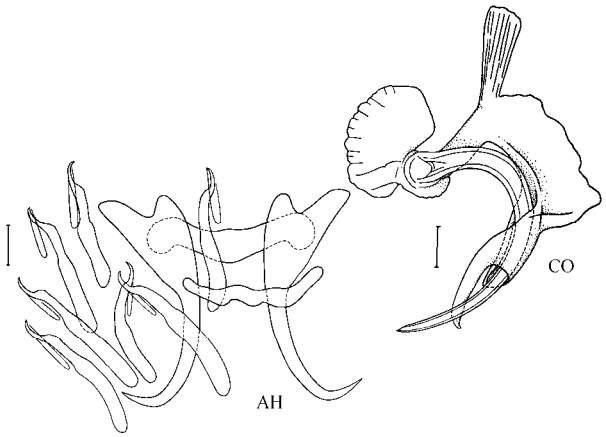
(Russia); Liao He River (China).



236



237



238

Fig. 236 – 238.
236 - *Dactylogyrus pseudogobii* from *Abbottina rivularis* (after Gussev, 1955a). **237** - *Dactylogyrus gobioninum* from *Saurogobio dabryi* (after Gussev, 1953, 1955a). **238** - *Dactylogyrus cristatus* (after Gussev, 1953, 1955a).

106 (103). The supporting projection of the initial part of the copulatory tube is massive (far longer than its diameter); the copulatory organ is massive and large (greater than 0.040 mm). These are parasites of the genus *Gobio*.

107 (108). The ridge of the accessory piece of the copulatory organ has a plum-like projection.
D. cristatus Gussev, 1953 (Fig. 238)

These are medium size or large worms; body can be up to 0.85 mm long and 0.21 mm wide. Length of marginal hooks is 0.029–0.040 mm. Length of anchors is 0.048–0.055 mm, main part 0.039–0.049 mm, inner root 0.008–0.012 mm, outer root 0.003–0.005 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.005–0.008 x 0.030–0.041 mm, ventral bar 0.003–0.006 x 0.023–0.039 mm. Length of copulatory organ is up to 0.080 mm, tube 0.056–0.090 mm. Vaginal armament is absent.

Found on gill filaments of *Gobio cynocephalus*; Amur River (Russia).

108 (107). The ridge of the accessory piece of the copulatory organ lacks projections.
D. cryptomeres Bychowsky, 1934, f. amurensis (Fig. 239)

This differs from the similar typical form from Europe in having a slightly smaller size, massive chitinoid structures of the haptor, and a shorter point of the anchors. Length of anchors is 0.040–0.045 mm, point 0.008–0.010 mm, marginal hooks 0.029–0.039 mm. Size of dorsal bar is 0.004–0.005 x 0.027–0.032 mm, ventral bar 0.003 x 0.027–0.029 mm. Length of copulatory organ is 0.040–0.050 mm.

Found on gill filaments of *Gobio soldatovi*; Amur River (Russia).

109 (102). The copulatory organ is of the "navicularis" type; the initial part of the tube lacks supporting projections; sometimes it has a thickened brim.

110 (111). The total length of the anchors is less than 0.030 mm. The longest marginal hooks are 1.5 times longer than the shortest ones.
D. trullaeformis Gussev, 1955 (Fig. 240)

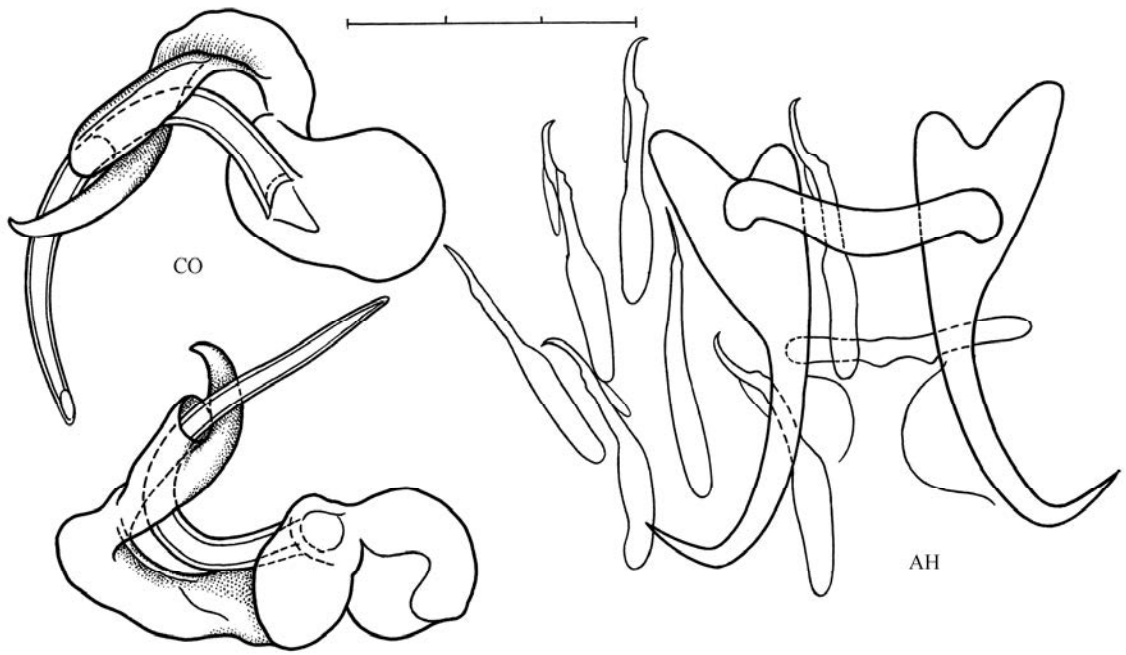
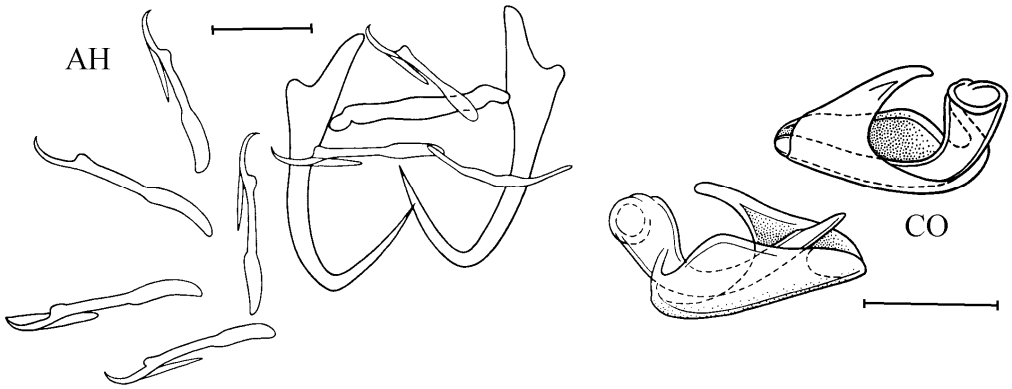
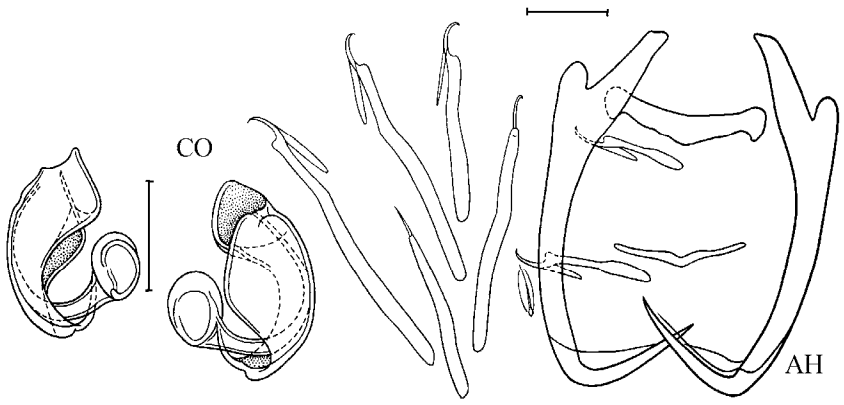


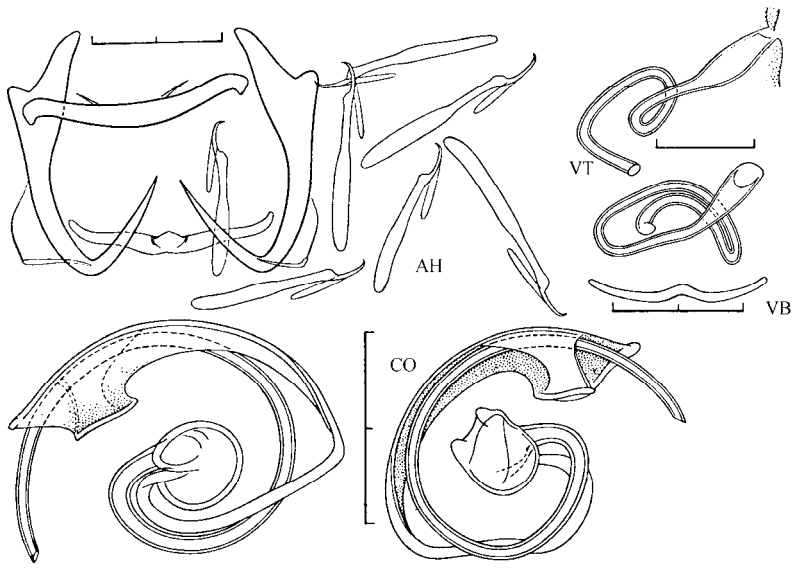
Fig. 239 - *Dactylogyrus cryptomeres* f. amurensis (after Gussev, 1953).



240



241



242

Fig. 240 – 242.
240 - *Dactylogyrus trullaeformis* (after Gussev, 1953, 1955a). **241 -** *Dactylogyrus navicularis* (after Gussev, 1953, 1955a). **242 -** *Dactylogyrus spirocirrus* (after Gussev, 1955a).

These are small worms; body can be up to 0.30 mm long and 0.05 mm wide. Length of marginal hooks is 0.015–0.023 mm. Length of anchors is 0.027–0.030 mm, main part 0.021–0.024 mm, inner root 0.006–0.008 mm, outer root 0.001–0.002 mm, point 0.011–0.013 mm. Size of dorsal bar is 0.002 x 0.017–0.019 mm, ventral bar 0.001 x 0.014–0.016 mm. Total length of copulatory organ is 0.018–0.020 mm. Vaginal armament is absent.

Found on gill filaments of *Gnathopogon strigatus* and *Squalidus chankaensis* (?); Amur River Basin (Russia).

111 (110). The total length of the anchors is greater than 0.040 mm; the longest marginal hooks are more than three times longer than the shortest ones.

D. navicularis Gussev, 1955 (Fig. 241)

These are small worms; body can be up to 0.24 mm long and 0.05 mm wide. Length of marginal hooks is 0.013–0.043 mm. Length of anchors is 0.041–0.048 mm, main part 0.033–0.040 mm, inner root 0.008–0.012 mm, outer root 0.003–0.004 mm, point 0.013–0.016 mm. Size of dorsal bar is 0.003–0.004 x 0.017–0.021 mm, ventral bar 0.001–0.002 x 0.017–0.021 mm. Length of copulatory organ is 0.014–0.020 mm. Vaginal armament is absent.

Found on gill filaments of *Sarcocheilichthys czerskii* and *S. sinensis*; Amur River Basin (Russia).

112 (111). The copulatory organ is of other types. These are parasites of other fish groups.

113 (124). The anchor point in most cases is longer than the inner root. These are parasites of the genus *Hemibarbus*.

114 (123). The copulatory tube is more or less thin walled, narrow, and twisted spirally in one plane; its initial part is bubble shaped and lacks supporting projections or has one short projection.

115 (118). The copulatory tube is uniformly twisted along its whole length, narrowing poorly to its end, or is nearly cylindrical (diameter 0.002–0.003 mm).

116 (117). The spiral of the copulatory tube has 1.5 spires; its posterior end is cut obliquely. The vaginal armament is a cylindrical tube that forms a loop with a widening at one end.

D. spirocirrus Gussev, 1955 (Fig. 242, 243)

These are small worms; body can be up to 0.35 mm long and 0.07 mm wide. Length of marginal hooks is 0.020–0.038 mm. Length of anchors is 0.035–0.038 mm, main part 0.025–0.030 mm, inner root 0.010–0.013 mm, outer root about 0.002 mm, point 0.015–0.018 mm. Size of dorsal bar is 0.004–0.005 x 0.031–0.035 mm, ventral bar 0.002–0.003 x 0.027–0.032 mm. Total length of copulatory organ is 0.030–0.034, tube along the curve 0.070–0.085. Length of vaginal tube is 0.045–0.065 mm.

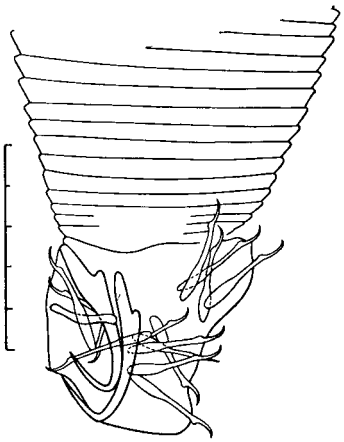
Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin (Russia).

117 (116). The spiral of the copulatory tube has one spire, its end is broadened like a bell. The vaginal armament is a bubble with a small tube.

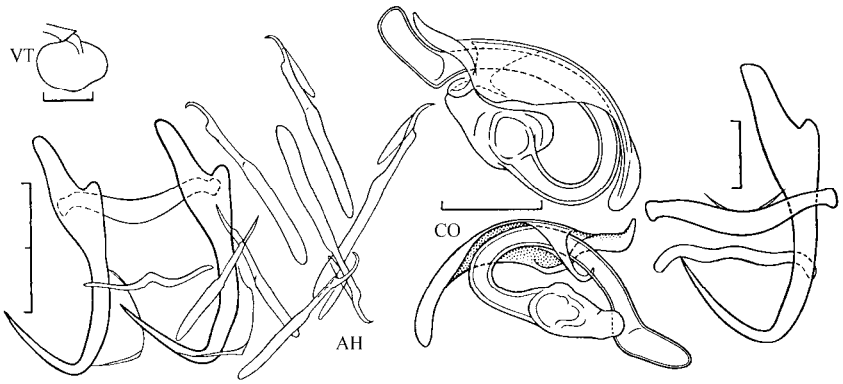
D. hemibarbi Akhmerov, 1952 (Fig. 244)

These are small worms; body can be up to 0.3 mm long and 0.08 mm wide. Length of marginal hooks is 0.020–0.033 mm. Length of anchors is 0.031–0.043 mm, main part 0.025–0.033 mm, inner root 0.009–0.012 mm, outer root 0.002–0.003 mm, point 0.013–0.019 mm. Size of dorsal bar is 0.002–0.004 x 0.022–0.029 mm, ventral bar 0.002–0.003 x 0.020–0.025 mm. Total length of copulatory organ is 0.028–0.032, tube 0.035–0.045 mm. Vaginal tube is nearly 0.005 mm long, diameter of vaginal bubble 0.010 mm.

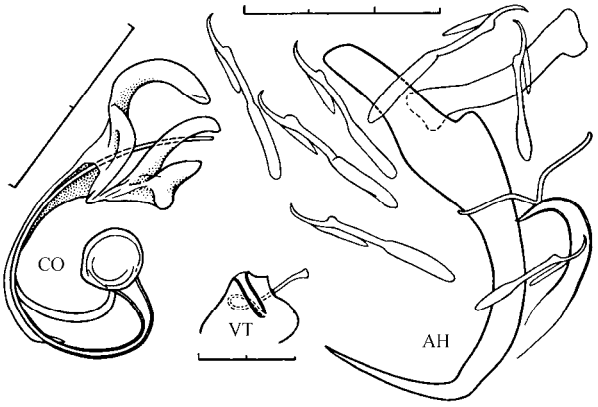
Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin (Russia).



243



244



245

Fig. 243 – 245.

243 - Posterior end of *Dactylogyrus spirocirrus* with typical indented rugosity of integument (after Gussev, 1955a). **244 -** *Dactylogyrus hemibarbi* (after Gussev, 1955a). **245 -** *Dactylogyrus rostrum* from *Hemibarbus maculates* (after Gussev, 1955a).

118 (115). The copulatory tube is straight at its end, sharply tapering from its initial part; width in its middle is less than 0.001 mm.

119 (120). The anchors are massive; their outer root is 10 times shorter than the inner one.
D. rostrum Gussev, 1955 (Fig. 245, 246)

These are small worms; body can be up to 0.35 mm long and 0.09 mm wide. Length of marginal hooks is 0.019–0.020 mm. Length of anchors is 0.053–0.060 mm, main part 0.041–0.045 mm, inner root 0.017–0.022 mm, outer root 0.001–0.002 mm, point 0.019–0.021 mm. Size of dorsal bar is 0.004 x 0.023–0.028 mm, ventral bar about 0.001 x 0.015 mm. Total length of copulatory organ is 0.031–0.035 mm, tube 0.045–0.061 mm. Length of vaginal tube is 0.030–0.035 mm.

Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin (Russia).

120 (119). The anchors are thin; their outer root is 3– 4 times shorter than the inner one.

121 (122). The vaginal armament is in the form of bubble with a short tube. The initial part of the copulatory tube has a short tongue-like supporting projection.
D. securiformis Gussev, 1955 (Fig. 247)

These are small worms; body can be up to 0.48 mm long and 0.10 mm wide. Length of marginal hooks is 0.017–0.027 mm. Length of anchors is 0.023–0.033 mm, main part 0.018–0.025 mm, inner root 0.007–0.010 mm, outer root 0.001–0.002 mm, point 0.011–0.014 mm. Size of dorsal bar is 0.002–0.004 x 0.023–0.029 mm, ventral bar 0.002 x 0.022–0.028 mm. Total length of copulatory organ is 0.021–0.025 mm, tube 0.030–0.040 mm. Length of short vaginal tube is 0.006 mm, with a bubble 0.015 mm in diameter.

Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin (Russia).

122 (121). The vaginal armament is in the form of a thin slightly bent tube with a funnel-like broadening at one end. The initial part of the copulatory tube lacks projections.
D. rarus Gussev, 1955 (Fig. 248)

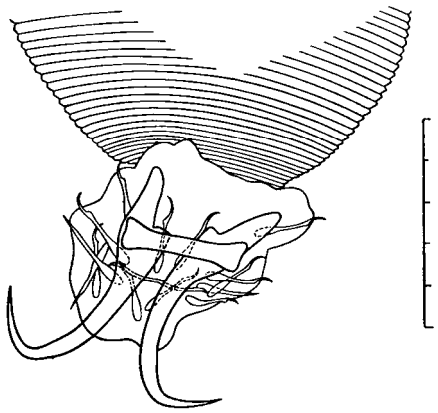
These are minute worms; body can be up to 0.25 mm long and 0.05 mm long. Length of marginal hooks is 0.014–0.024 mm. Length of anchors is 0.026–0.033 mm, main part 0.022–0.027 mm, inner root 0.006–0.008 mm, outer root 0.002 mm, point 0.011–0.013 mm. Size of dorsal bar is 0.002–0.003 x 0.019–0.024 mm, ventral bar 0.002 x 0.019–0.020 mm. Total length of copulatory organ is 0.023–0.029 mm, tube 0.045–0.047 mm. Length of thin vaginal tube is about 0.017 mm.

Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin (Russia).

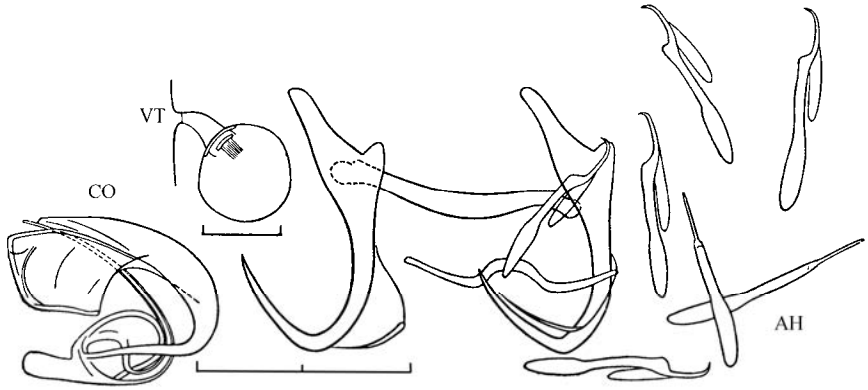
123 (114). The copulatory tube is thick walled, wide, **Γ** shaped, and bent with a massive supporting projection at its initial part.
D. grandicirrus Gussev, 1955 (Fig. 249)

These are small worms; body can be up to 0.4 mm long and 0.008 mm wide. Length of marginal hooks is 0.019–0.035 mm. Length of anchors is 0.024–0.040 mm, main part 0.022–0.032 mm, inner root 0.008–0.010 mm, outer root 0.001–0.002 mm, point 0.013–0.018 mm. Size of dorsal bar is 0.003–0.004 x 0.018–0.037 mm, ventral bar 0.002 x 0.029–0.036 mm. Total length of copulatory organ is 0.049–0.068 mm, tube 0.048–0.056 mm. Vaginal armament is a thin bubble-like structure.

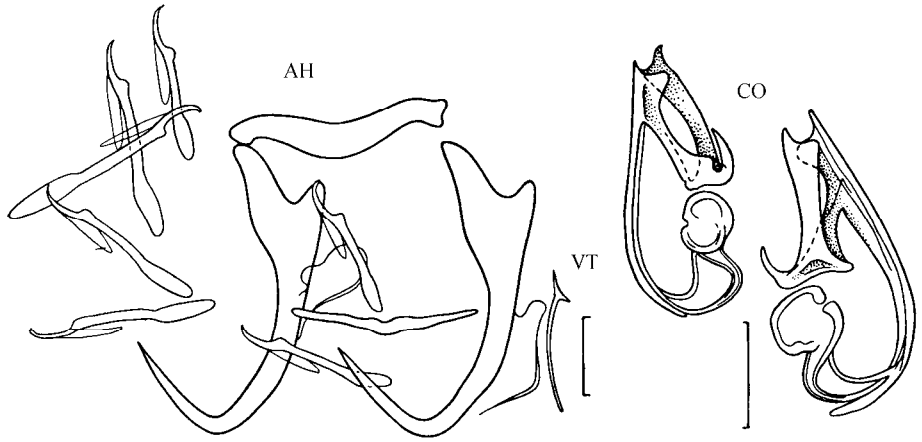
Found on gill filaments of *Hemibarbus maculates*; Amur River Basin (Russia).



246

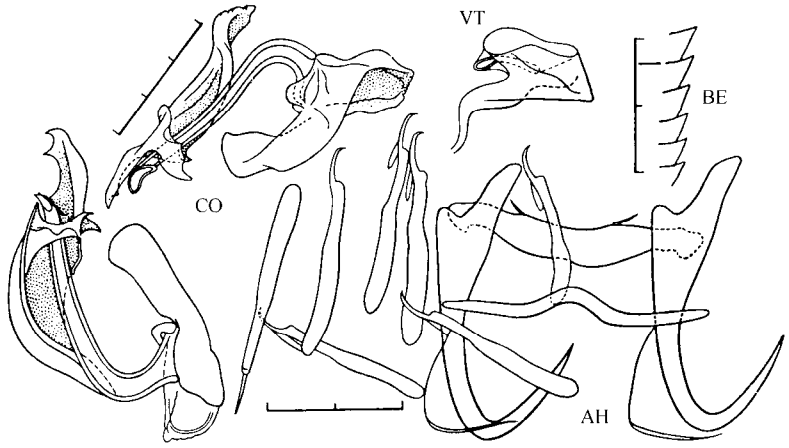


247

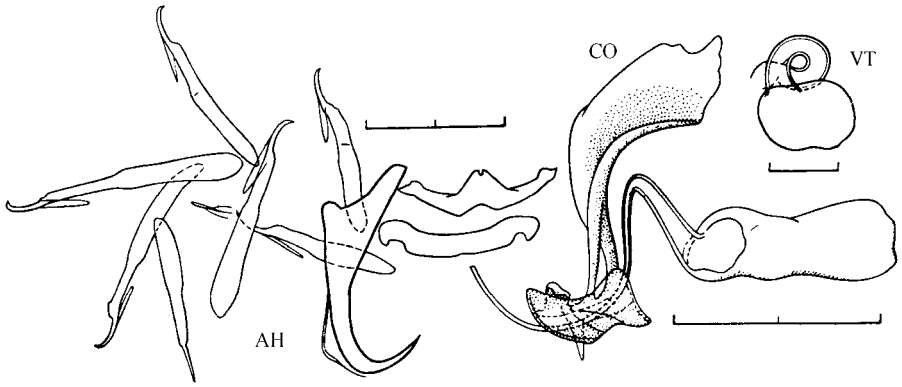


248

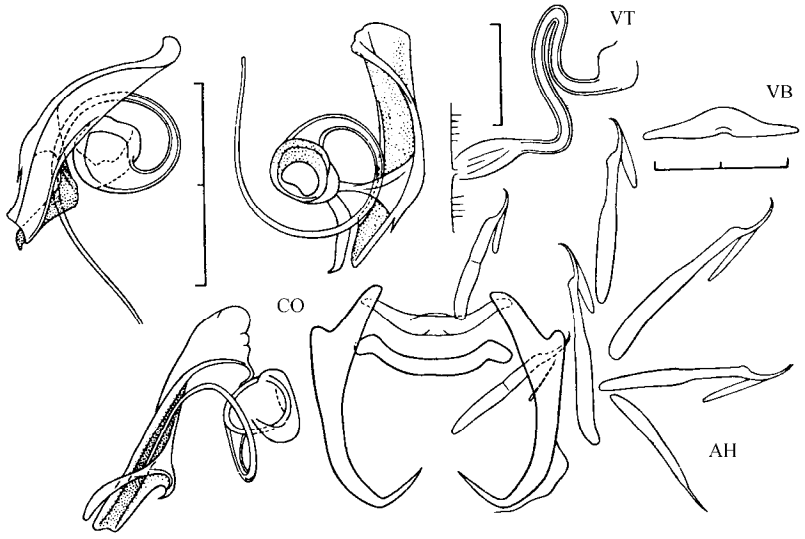
Fig. 246 – 248.
246 - Posterior end of *Dactylogyrus rostrum* with typical indented rugosity of integument (after Gussev, 1955a). **247 -** *Dactylogyrus securiformis* (after Gussev, 1955a). **248 -** *Dactylogyrus rarus* (after Gussev, 1955a).



249



250



251

Fig. 249 – 251.
249 - *Dactylogyrus grandicirrus* (after Gussev, 1955a). **250** - *Dactylogyrus clavaeformis* (after Gussev, 1955a). **251** - *Dactylogyrus nikolskyi* (after Gussev, 1955a).

124 (113). The anchor point is not longer than the inner root. These are parasites of Cultrinae[47].

125 (132). The vaginal armament is present.

126 (129). The copulatory tube is twisted to form a spiral. These are parasites of the genus *Hemiculter*.

127 (128). The initial part of the copulatory tube has a massive supporting projection.
D. clavaeformis Gussev, 1955 (Fig. 250)

These are small or medium sized worms; body can be up to 0.66 mm long and 0.10 mm wide. Length of marginal hooks is 0.023–0.035 (0.019–0.037)[48] mm. Length of anchors is 0.031–0.034 (0.025–0.032) mm, main part 0.025–0.028 mm, inner root 0.007–0.011 mm, outer root 0.002 mm, point 0.008–0.010 (0.006–0.008) mm. Size of dorsal bar is 0.002–0.003 x 0.022–0.029 mm, ventral bar 0.004–0.005 x 0.024–0.030 mm. Total length of copulatory organ is 0.040–0.047 (0.027–0.045) mm, tube 0.047–0.050 mm (excluding projection). Length of bent vaginal tube is 0.020–0.030 mm, diameter of bubble 0.013–0.015 mm.

Found on gill filaments of *Hemiculter leucisculus*; Amur River Basin (Russia); Liao He River (China).

128 (127). The initial part of the copulatory tube has a small finger-shaped projection.
D. nikolskyi Gussev, 1955 (Fig. 251)

These are small worms; body can be up to 0.44 mm long and 0.11 mm wide. Length of marginal hooks is 0.019–0.035 mm. Length of anchors is 0.031–0.033 mm, main part 0.024–0.028 mm, inner root 0.010 mm, outer root 0.002 mm, point 0.007–0.008 mm. Size of dorsal bar is 0.002 x 0.019–0.023 mm, ventral bar 0.002–0.004 x 0.020–0.025 mm. Total length of copulatory organ is 0.025–0.035 mm, tube along the curve 0.034–0.055 mm. Length of vaginal tube is 0.030–0.040 mm.

Found on gill filaments of *Hemiculter leucisculus*; Amur River Basin (Russia).

129 (126). The copulatory tube is **S**, **C**, or **Γ** shaped. These are parasites of different fish species of the subfamily Cultrinae.

130 (131). The copulatory tube is **S** shaped and its accessory piece is leaf shaped; marginal hooks are thin and short and their handles are clear delimited from the pivots; the heel of the point is protruded. These are parasites of the genus *Chanodichthys*.
D. foliicirrus Gussev, 1955 (Fig. 252)

These are minute worms; body can be up to 0.3 mm long and 0.08 mm wide. Length of marginal hooks is 0.018–0.026 mm. Length of anchors is 0.031–0.038 (0.025–0.027)[49] mm, main part 0.023–0.028 mm, inner root 0.012–0.015 mm, outer root 0.001–0.004 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.004 x 0.020–0.024 mm; **V**-shaped ventral bar 0.001 x 0.009–0.013 mm. Length of copulatory organ is 0.044–0.060 mm, vaginal tube about 0.020 mm.

Found on gill filaments of *Chanodichthys erythropterus*; Amur River Basin (Russia); Liao He River (China); in the Yangtze River it also is found on *Chanodichthys dabryi* (China).

131 (130). The copulatory tube is **Γ** shaped; its accessory piece is a wing-shaped plate that embraces the

[47] *D. aristichthys* Long et Yu, 1958 and *D. nobilis* Long et Yan, 1958 from *Aristichthys nobilis* described from China are to be put in the limits of theses 121–129 because of the shape of their chitinoid structures (see Supplement). This fish species is not of Amur River fauna but is cultured in many fish farms of the former USSR, where both of these species have been found in large quantities (especially the first). *D. taihuensis* also can be found there.
[48] Data in brackets are from Chen et al. (1973).
[49] Data in brackets are from Chen et al. (1973).

tube. The marginal hooks are long and have the handles that are poorly delimited from the pivots; the point's heel is smooth. This is a parasite of *Culter alburnus.*

D. alatocirrus Gussev, 1955 (Fig. 253)

These are small worms; body can be up to 0.6 mm long and 0.08 mm wide. Length of marginal hooks is 0.033–0.041 mm. Length of anchors is 0.039–0.044 mm, main part 0.033–0.035 mm, inner root 0.010–0.013 mm, outer root 0.002–0.003 mm, point 0.010–0.013 mm. Size of dorsal bar is 0.003–0.004 x 0.027–0.031 (0.035–0.040)[50] mm, ventral bar 0.003–0.005 x 0.020–0.025 mm. Length of copulatory organ is 0.028–0.030 (0.030–0.040) mm. Short vaginal tube has a bubble with a diameter of about 0.020 mm.

Found on gill filaments of *Culter alburnus*; Amur River Basin (Russia); *Chanodichthys dabryi* is its host in the Yangtze River (China).

132 (125). Vaginal armament is absent.

133 (150). The copulatory tube is rather thin and long; the diameter of its middle part is more than nine times less than its length.

134 (141). The copulatory tube is sickle shaped. The marginal hooks have the pivots that are poorly delimited from the handles and they have a smoothed point heel.

135 (136). The initial part of the copulatory tube has a massive supporting projection; the accessory piece resembles a bent plate without projections.

D. achmerowianus Gussev, 1955 (Fig. 254)[51]

These worms are medium or large; body can be up to 1.6 mm long and 0.24 mm wide. Length of massive marginal hooks is 0.039–0.054 mm. Length of anchors is 0.047–0.056 mm, main part 0.035–0.046 mm, inner root 0.012–0.017 mm, outer root 0.002–0.004 mm, point 0.016–0.021 mm. Size of dorsal bar is 0.008–0.012 x 0.045–0.061 mm, ventral bar 0.003–0.006 x 0.035–0.045 mm. Length of copulatory organ is 0.030–0.039 mm.

Found on gill filaments of *Elopichthys bambusa*; Amur River Basin (Russia); Yangtze River (China).

136 (135). The initial part of the copulatory tube may or may not have a small supporting plate; the accessory piece is of another more complicated shape.

137 (138). The accessory piece of the copulatory organ consists of long “rags” that cover almost the whole tube.

D. gussevi Akhmerov, 1952 (Fig. 255)

These are small or medium size worms; body can be up to 0.64 mm long and 0.11 mm wide. Length of marginal hooks is 0.029–0.042 mm. Length of anchors is 0.042–0.052 (0.031–0.040)[52] mm, main part 0.037–0.043 mm, inner root 0.010–0.015 mm, outer root 0.002–0.004 mm, point 0.013–0.017 (0.010–0.013) mm. Size of dorsal bar is 0.004–0.007 x 0.031–0.047 mm, ventral bar 0.002–0.004 x 0.031–0.048 mm. Total length of copulatory organ is 0.060–0.079 mm, tube along the curve 0.083–0.097 mm.

Found on gill filaments of *Chanodichthys mongolicus* and *Elopichthys bambusa* (?); Amur River Basin (Russia); Yangtze River (China).

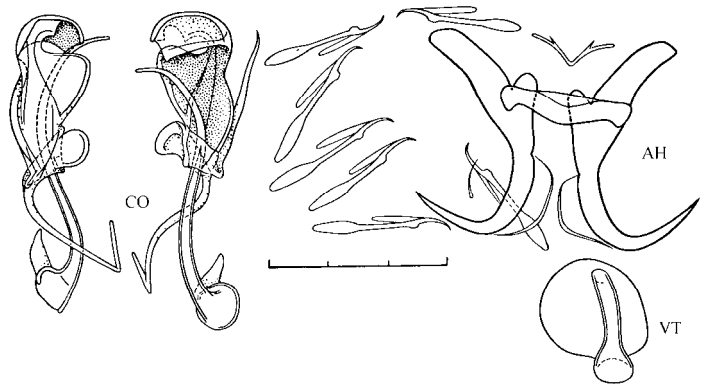
138 (137). The accessory piece of the copulatory organ has a long projection in its middle part that

[50] Data in brackets are from Chen et al. (1973).

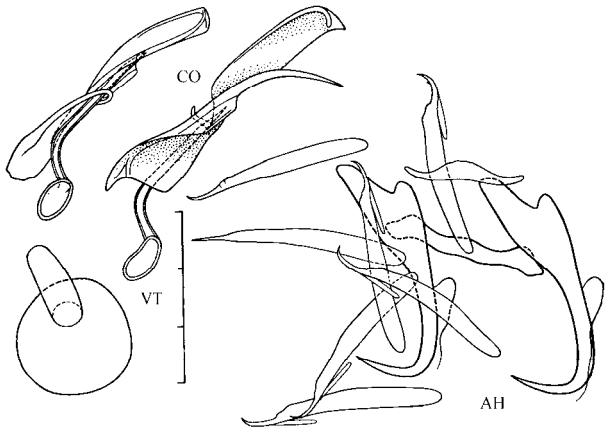
[51] In the original description and in Strelkov (1971), the size of all chitinoid structures of the Amur specimens are nearer to the minimum values; the values from Lakes Khanka and Bolon’ are nearer to the maximum.

[52] Data in brackets are from Chen et al. (1973).

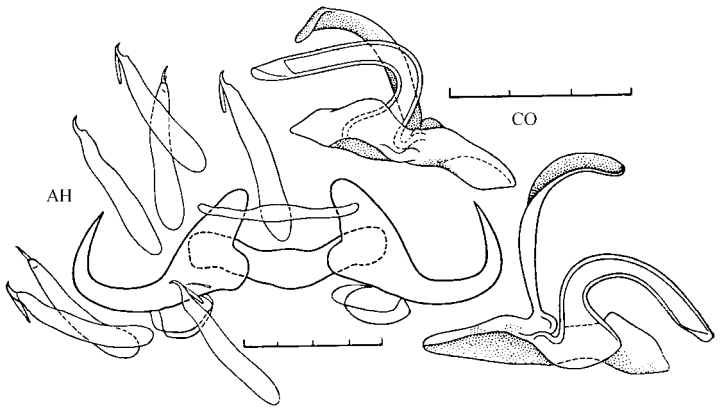
forms a gutter through which the tube runs.



252

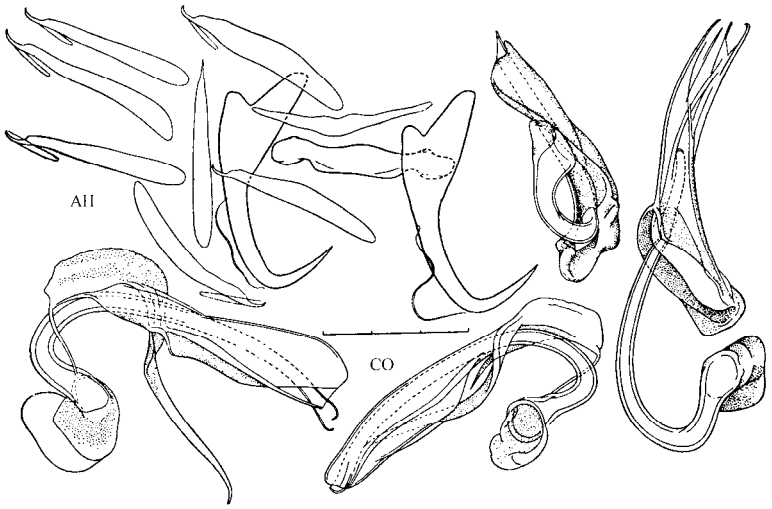


253

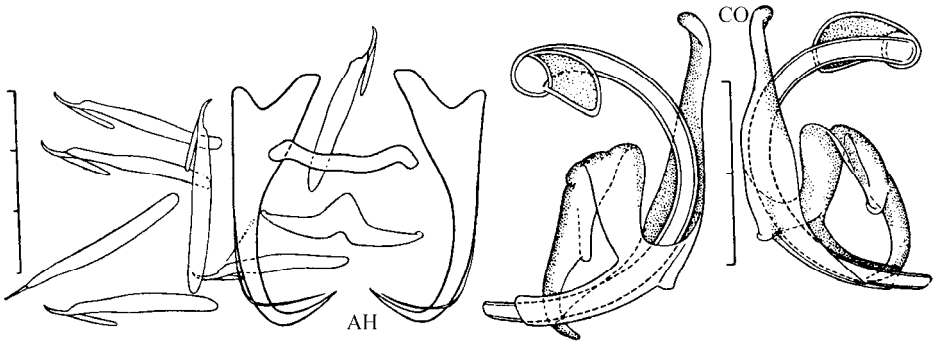


254

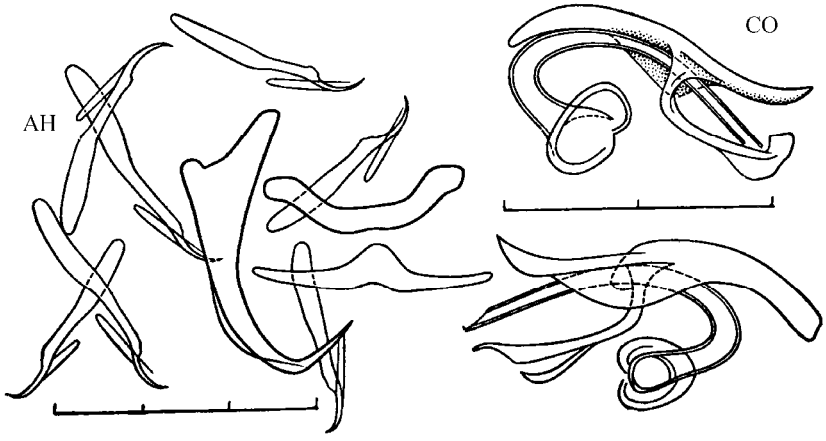
Fig. 252 – 254.
252 - *Dactylogyrus foliicirrus* (after Gussev, 1955a). **253 -** *Dactylogyrus alatocirrus* (after Gussev, 1955a). **254 -** *Dactylogyrus achmerowianus* (after Gussev, 1955a).



255



256



257

Fig. 255 – 257.
255 - *Dactylogyrus gussevi* (after Gussev, 1955a). **256** - *Dactylogyrus leucisculus* (after Gussev, 1955a). **257** - *Dactylogyrus brachius* (after Gussev, 1955a).

139 (140). The initial part of the copulatory organ does not broaden and has a thin ear-shaped supporting plate; the tube is nearly cylindrical.

D. leucisculus Gussev, 1955 (Fig. 256)

These are small worms; body can be up to 0.5 mm long and 0.12 mm wide. Length of marginal hooks is 0.023–0.035 (0.018–0.024) mm. Length of anchors is 0.037–0.041 (0.027) mm, main part 0.031–0.036 mm, inner root 0.006–0.010 mm, outer root 0.003–0.004 (0.001) mm, point 0.008–0.010 mm. Size of dorsal bar is 0.002–0.004 x 0.025–0.031 mm, ventral bar 0.008–0.010 x 0.025–0.031 mm. Total length of copulatory organ is 0.030–0.041 mm.

Found on gill filaments of *Hemiculter leucisculus* and *H. lucidus*; Amur River Basin; Liao He and Yangtze Rivers (China).

140 (139). The initial part of the copulatory tube has a discoid broadening; the tube becomes narrower towards the posterior end.

D. brachius Gussev, 1955 (Fig. 257)

These are small or medium size worms; body can be up to 0.6 mm long and 0.12 mm wide. Length of marginal hooks is 0.022–0.029 mm. Length of anchors is about 0.031 mm, main part 0.025–0.026 mm, inner root 0.010 mm, outer root 0.002 mm, point 0.009 mm. Size of dorsal bar is 0.003 x 0.023 mm, ventral bar 0.004 x 0.025–0.026 mm. Total length of copulatory organ is 0.025–0.029 mm.

Found on gill filaments of *Hemiculter leucisculus*; Lake Khanka (Russia); Liao He River (China).

141 (134). The copulatory tube is of another shape. The pivot of the marginal hooks is clear delimited from a broad handle; the point's heel can be protruded or smooth.

142 (147). The copulatory tube forms a rather straightened corkscrew-shaped spiral. The point's heel can be protruded or smooth.

143 (146). In its posterior part, the accessory piece of the copulatory organ forms a ring through which the tube passes. The ventral bar of the haptor is very thin; the marginal hooks are thin and the point's heel is protruded.

144 (145). The length of the anchors is greater than 0.047 mm.

D. branchialis Gussev, 1955 (Fig. 258)

These are small or medium size worms; body can be up to 0.65 mm long and 0.12 mm wide. Length of marginal hooks is 0.022–0.030 mm. Length of anchors is 0.051–0.056 (0.048–0.051)[53] mm, main part 0.039–0.044 mm, inner root 0.017–0.022 mm, outer root 0.001–0.003 mm, point 0.021–0.025 mm. Size of dorsal bar is 0.006–0.008 x 0.035–0.040 mm, ventral bar 0.001–0.002 x 0.019–0.029 mm. Length of copulatory tube is 0.048–0.058 mm.

Found on gill filaments of *Chanodichthys oxycephalus*; Amur River Basin (Russia); Yangtze River (China).

145 (144). The length of the anchors is less than 0.045 mm.

D. pterygialis Gussev, 1955 (Fig. 259)

These are small worms; body length is less than 0.5 mm, width 0.10 mm. Length of marginal hooks is 0.020–0.027 mm. Length of anchors is about 0.033 (0.043–0.044)[54] mm, main part 0.027–0.028 mm, inner root 0.011–0.012 (0.014–0.017) mm, outer root 0.001–0.003 mm, point 0.010–0.012 (0.017–0.018) mm. Size of dorsal bar is 0.003–0.004 x 0.030–0.031 (0.006–0.008 x 0.039–0.046) mm, ventral bar 0.002 x 0.014–0.016 mm. Length of copulatory organ is 0.029–0.035 (0.048–0.049) mm.

Found on dorsal and ventral fins of *Chanodichthys oxycephalus*; Lake Khanka (Russia); Yangtze River (China).

[53] Data in brackets are from Chen et al. (1973).

[54] Data in brackets are from Chen et al. (1973).

146 (153). The accessory piece of the copulatory organ is bifurcated in the middle part and both projections twine around the tube following its spiral bending; the ventral bar of the haptor is massive and saddle shaped in the middle; the marginal hooks are rather thick; the heel of the point is smooth.

D. contortus Gussev, 1955 (Fig. 260)

These are small worms; body can be up to 0.4 mm long and 0.08 mm wide. Length of marginal hooks is 0.030–0.046 mm. Length of anchors is 0.040–0.052 mm, inner root 0.012–0.015 mm, outer root 0.002 mm, point 0.013–0.014 mm. Size of dorsal bar is 0.005–0.007 x 0.044–0.052 mm, ventral bar 0.004–0.005 x 0.030–0.035 mm. Length of copulatory organ is 0.039–0.049 mm.

Found on gill filaments of *Chanodichthys erythropterus*; Amur River Basin (Russia); Yangtze River (China).

147 (142). The copulatory tube is nearly straight or its ends are bent; the heel of the point of the marginal hooks protrudes weakly.

148 (149). The accessory piece of the copulatory organ resembles a simple rachis-like plate that is bifurcated at its end; the tube is nearly straight (typical form) or has bent ends (second form).

D. eigenmanni Gussev, 1955 (Fig. 261)

These are small or medium size worms; body can be up to 0.62 mm long and 0.15 mm wide. Length of marginal hooks is 0.019–0.043 mm. Length of anchors is 0.033–0.038 mm, main part 0.025–0.031 mm, inner root 0.008–0.013 mm, outer root 0.002 mm, point 0.007–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.019–0.027 mm, ventral bar 0.002–0.006 x 0.021–0.030 mm. The copulatory tube is rather short, broad, nearly straight, slightly S shaped, and broadened at both ends; length is 0.030–0.039 in the typical form; tube of the second form is longer and more narrow with bent ends, and only the initial one is broadened; length 0.038–0.048 mm.

Found on gill filaments of *Hemiculter leucisculus;* Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

149 (148). The accessory piece of the copulatory organ is shaped like a rachis-like plate; its middle part has a projection and two small lobes that surround the tube; the ends of the tube are bent.

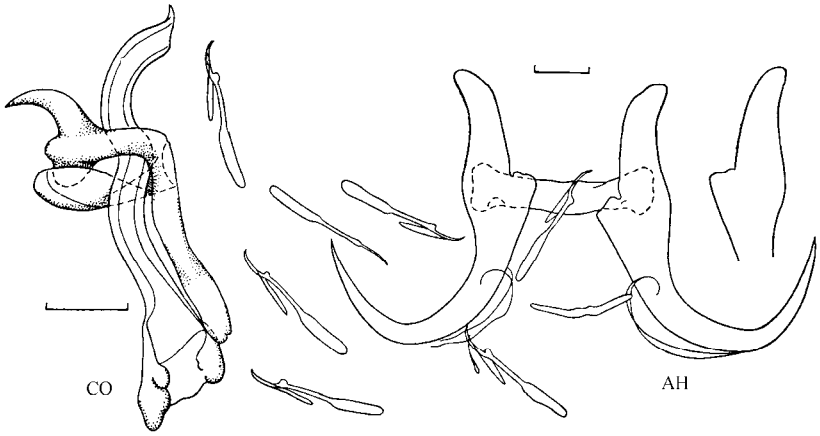
D. latituba Gussev, 1955 (Fig. 262)

These are small or medium size worms; body can be up to 0.6 mm long and 0.12 mm wide. Length of marginal hooks is 0.017–0.043 mm. Length of anchors is 0.029–0.038 mm, main part 0.022–0.031 mm, inner root 0.008–0.013 mm, outer root 0.002–0.003 mm, point 0.009–0.012 mm. Size of dorsal bar is 0.002–0.004 x 0.021–0.031 mm, ventral bar 0.002– 0.004 x 0.023–0.031 mm. Total length of copulatory organ is 0.039–0.060 mm, tube along the curve 0.043–0.065 mm.

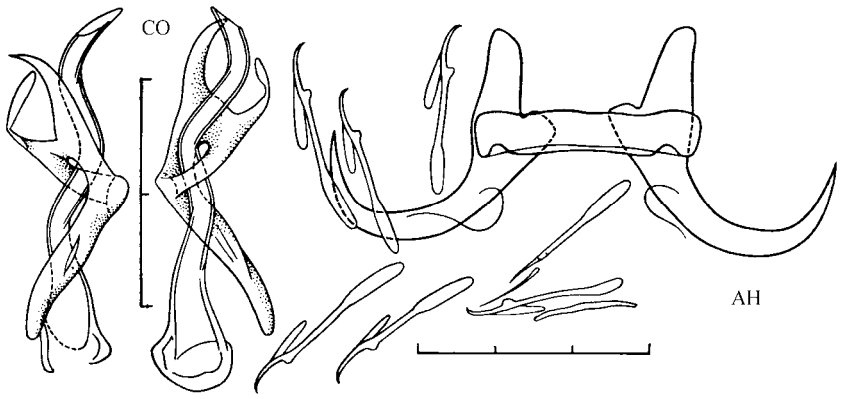
Found on gill filaments of *Hemiculter leucisculus*; Amur River Basin (Russia); Yangtze River (China).

150 (133). The copulatory tube is rather wide and short; its diameter in the middle is less than six times shorter than its length.

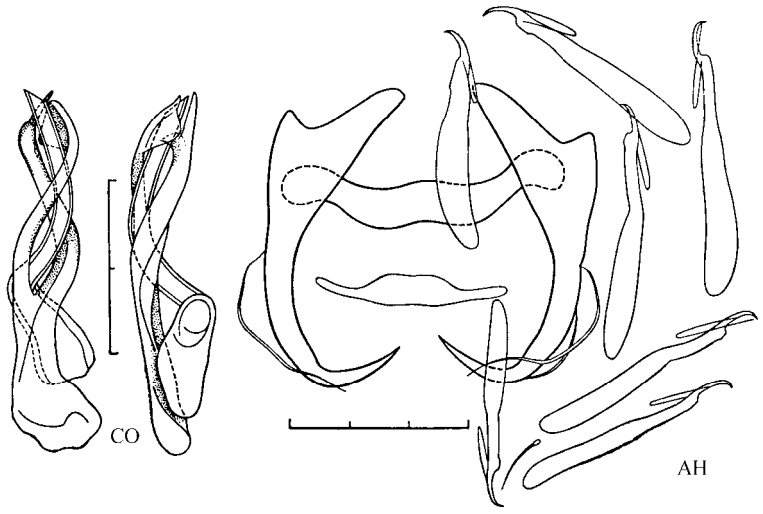
D. erythropteris Akhmerov, 1952 (Fig. 263)



258



259



260

Fig. 258 – 260.
258 - *Dactylogyrus branchialis* (after Gussev, 1955a). **259** - *Dactylogyrus pterygialis* (after Gussev, 1955a). **260** -*Dactylogyrus contortus* (after Gussev, 1955a).

These are small or medium size worms; body can be up to 0.85 mm long and 0.22 mm wide. Marginal hooks are rough and have a feebly marked boundary between the pivot and handle and a smooth heel; length 0.029–0.048 mm. Length of anchors is 0.043–0.060 mm, their main part 0.036 - 0.053, inner root 0.012 - 0.016, outer root 0.002 - 0.004, point 0.012–0.019 mm. Size of dorsal bar is 0.005–0.009 x 0.040–0.050 mm, ventral bar 0.003–0.004 x 0.029–0.040 mm. Total length of copulatory organ is 0.025–0.031 (in Achmerow,1952: up to 0.038) mm.

Found on gill filaments of *Chanodichthys erythropterus*; Amur River Basin (Russia); Yangtze River (China).

151 (99). The ventral bar of the haptor has a projection.

152 (165). The ventral bar has an anterior projection and is ⊥ shaped.

153 (164). The anterior projection of the ventral bar is in most cases pointed and shorter than its lateral wings. The copulatory organ is of the “anchoratus–borealis” type or some modified type; the vaginal armament is absent. These are parasites of the genus *Phoxinus* (the "phoxini" morphological group).

154 (163). The anchors have a small outer root that is several times smaller than the inner one.

155 (162). The accessory piece of the copulatory organ is in the form of a plate with four lobes and is shaped like the letter **H** or **A**.

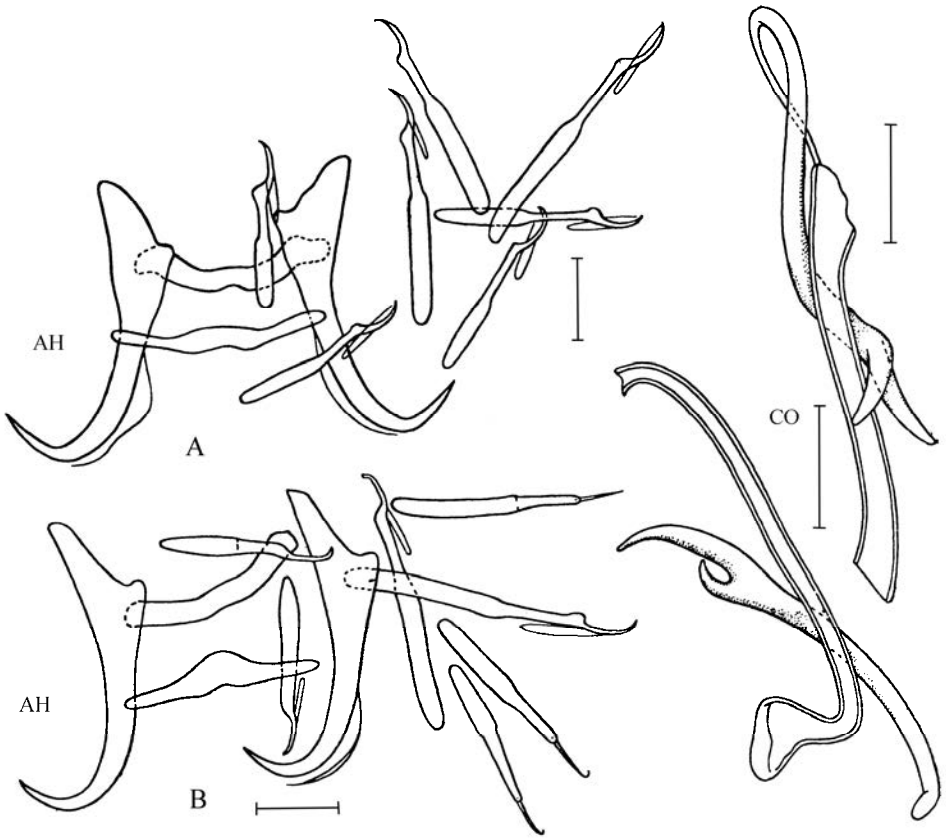
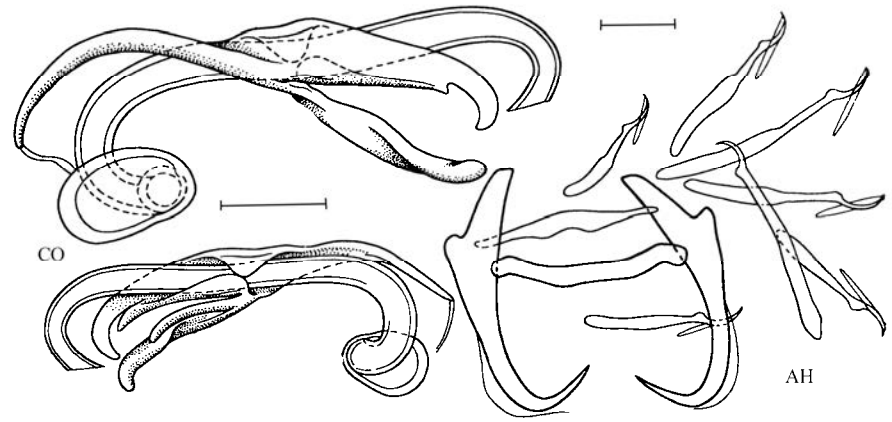
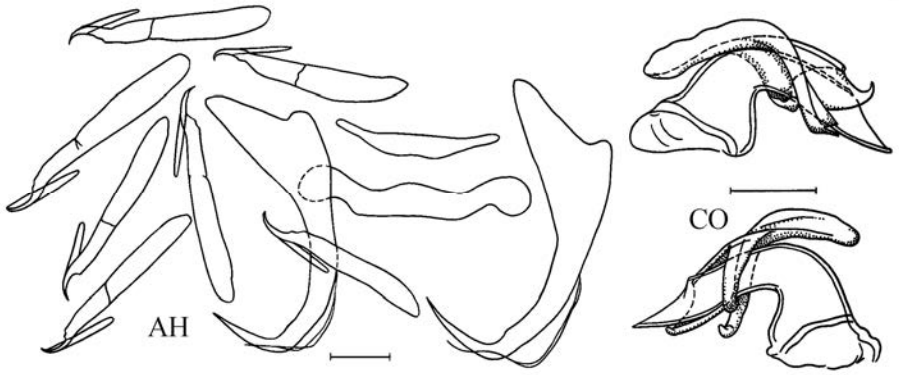


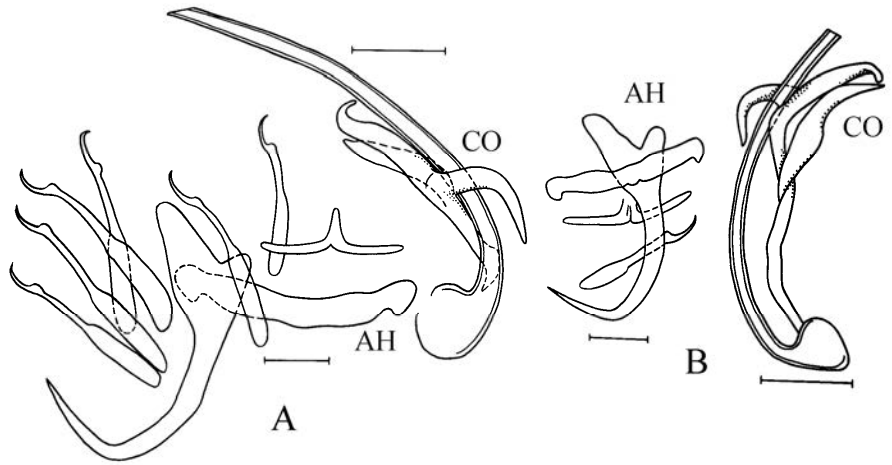
Fig. 261 - *Dactylogyrus eigenmanni*.
A – typical form, B – form with more narrow curved copulatory tube (after Gussev, 1955a).



262



263



264

Fig. 262 – 264.
262 - *Dactylogyrus latituba* (after Gussev, 1955a). **263 -** *Dactylogyrus erythropteris* (after Gussev, 1955a). **264 -** *Dactylogyrus malewitzkajae*: A – specimen from ZIN RAS collection (sample of 1911 year), B – specimen from sample of 1948 year (both from Lake Khanka, Russia) (after Gussev, 1955a).

156 (157). The length of the copulatory tube is less than 0.040 mm and its diameter is less than 0.002 mm.
D. phoxini Malewitzkaja, 1949 (Fig. 113)

157 (156). The length of the copulatory tube is greater than 0.040 mm and its diameter is greater than 0.002 mm.

158 (161). The length of the anchors is greater than 0.040 mm; the copulatory tube is sharply bent just after its initial part; its opening is on the slanting cut distal end.

159 (160). The length of the copulatory tube is greater than 0.050 mm.
D. malewitzkajae Gussev, 1955 (Fig. 264)

These are minute worms; body can be up to 0.4 mm long and 0.10 mm wide. Length of marginal hooks is 0.023–0.035 mm. Length of anchors is about 0.043 mm, main part 0.035–0.037 mm, inner root 0.010–0.012 mm, outer root 0.003–0.005 mm, point 0.015–0.017 mm. Size of dorsal bar is 0.004–0.005 x 0.033–0.039 mm, ventral bar 0.004 x 0.019–0.021 mm. Total length of copulatory organ is 0.040–0.50, tube 0.051–0.060 mm.

Found on gill filaments of *Phoxinus phoxinus, P. percnurus,* and *P. p. mantschuricus*; Lena and Amur Rivers (Russia).

160 (159). The length of the copulatory tube is less than 0.050 mm.
D. gvosdevi Gussev, 1955 (Fig. 265)

These are minute worms; body can be up to 0.3 mm long and 0.10 mm wide. Length of marginal hooks is 0.019–0.031 mm. Length of anchors is 0.040–0.060 mm, main part 0.030–0.042 mm, inner root 0.014–0.025 mm, outer root 0.003–0.004 mm, point 0.013–0.020 mm. Size of dorsal bar is 0.004–0.005 x 0.029–0.035 mm, ventral bar about 0.003 x 0.016 mm. Length of copulatory organ is about 0.035 mm, tube 0.035–0.048 mm.

Found on gill filaments of *Phoxinus percnurus mantschuricus* and *P. czekanowskii czerskii*; Lake Khanka (Russia).

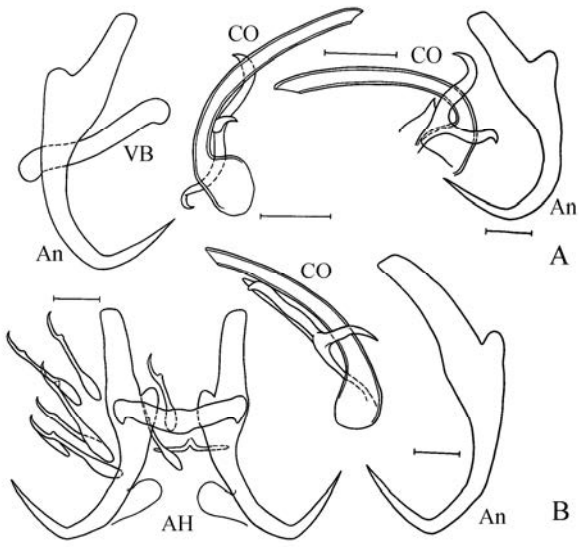


Fig. 265 - *Dactylogyrus gvosdevi*.

A – specimen from *Phoxinus czekanowskii czerskii*, B – specimen from *Phoxinus percnurus mantschuricus* (after Gussev, 1955a).

161 (158). The length of the anchors is less than 0.040 mm. The copulatory tube is bent only in its posterior half; its opening is on the slanting cut distal end.
D. amurensis Akhmerov, 1952 (Fig. 266)

These are minute worms; body length is less than 0.3 mm, width up to 0.08 mm. Length of marginal hooks is 0.015–0.025 mm. Length of anchors is 0.029–0.039 mm, main part 0.023–0.029 mm, inner root 0.007–0.010 mm, outer root 0.002–0.004 mm; point 0.008–0.013 mm. Size of dorsal bar is 0.002–0.004 x 0.019–0.029 mm, ventral bar 0.002–0.005 x 0.013–0.020 mm. Length of copulatory organ is 0.030–0.043 mm, tube 0.035–0.050 mm, diameter 0.003–0.004 mm.

Found on gill filaments of *Phoxinus oxicephalus* and *P. lagowskii* (Akhmerov, 1952 wrote that its host is *Phoxinus percnurus* but this is rather doubtful); Amur River Basin (Russia).

162 (155). The accessory piece of the copulatory organ is in the form of a four-lobed plate that forms an **X**-shaped figure.
D. czerskii Gussev, 1955 (Fig. 267)

These are small worms; body can be up to 0.45 mm long and 0.12 mm wide. Length of marginal hooks is 0.019–0.025 mm. Length of anchors is 0.029–0.031 mm, main part 0.025–0.027 mm, inner root 0.006–0.008 mm, outer root about 0.002 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.020–0.023 mm, ventral bar 0.002 x 0.014 mm. Length of copulatory organ is 0.035–0.045 mm, diameter of tube about 0.003 mm.

Found on gill filaments of *Phoxinus czekanowskii czerskii*; Lake Khanka (Russia).

163 (154). The inner and outer roots of the anchors are the same length.
D. borealis Nybelin, 1936 (Fig. 112)

164 (153). The anterior projection of the ventral bar is nearly cylindrical and is as long as the lateral wings of the bar. The copulatory organ is of the "ramulosus" type; the vaginal armament is a massive cigar-shaped structure. This is a parasite of the genera *Leuciscus* and *Rutilus*.
D. ramulosus Malewitzkaja, 1941 (Fig.268, 142)

165 (152). The ventral bar has a posterior **T**-shaped projection. The vaginal armament may be present or absent. These are parasites of fishes mainly of the subfamily Cultrinae, rare for other groups.

166 (205). The posterior projection of the ventral bar is equal to or more than half of transverse wing of bar.

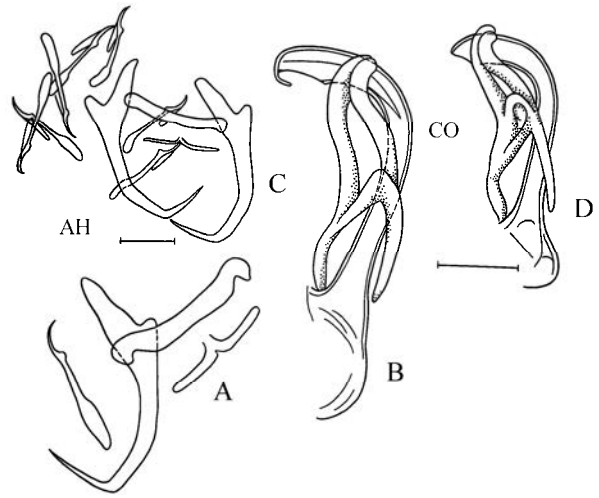
167 (168). The anchors have an ear-like projection on the inner side of the main part before the point.
D. pterocleidus Gussev, 1955 (Fig. 269)[55]

These are minute worms; body can be up to 0.4 mm long and 0.09 mm wide. Length of marginal hooks is 0.021–0.030 mm. Length of anchors is 0.049–0.055 mm, main part 0.033–0.036 mm, inner root 0.018–0.020 mm, outer root 0.003–0.004 mm, point 0.027–0.029 mm. Size of dorsal bar is 0.004–0.007 x 0.035–0.043 mm, ventral bar 0.017–0.025 (with a projection) x 0.020–0.025 mm. Total length of copulatory organ is 0.030–0.040 mm. Vaginal armament is absent.

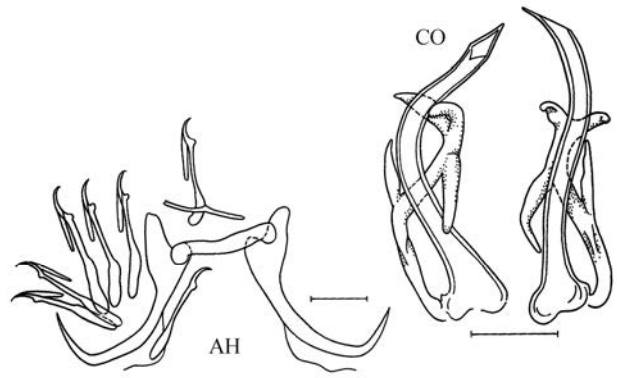
Found on gill filaments of *Chanodichthys oxycephalus* and *Chanodichthys dabryi*; Lake Khanka (Russia); Yangtze River (China).

168 (167). The anchors lack a projection on the main part; sometimes the main part are slightly thicker before it turns into the point.

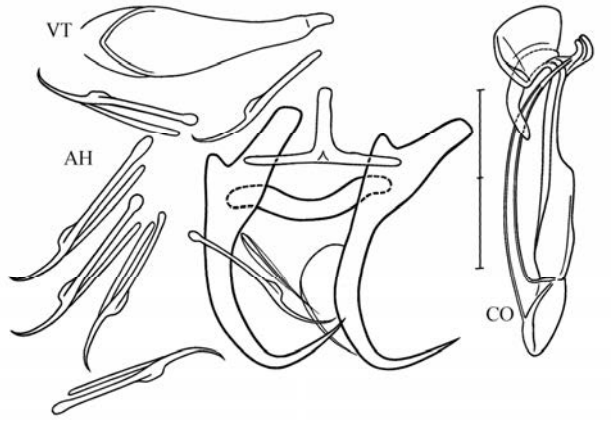
[55] A similar species, *D. parapterocleidus* Long, 1964, was described from *Culter alburnus* in China (see Supplement).



266



267



268

Fig. 266 – 268.
266 - *Dactylogyrus amurensis*: A, B – specimen from ZIN RAS collection (sample of 1911 year), D, C – specimen from sample of 1948 year (both from Lake Khanka, Russia) (after Gussev, 1955a). **267 -** *Dactylogyrus czerskii* from Lake Khanka, Russia (after Gussev, 1955a). **268 -** *Dactylogyrus ramulosus* from Amur River.

169 (198). The posterior projection of the ventral bar is linguiform; two small outgrowths are present at the posterior edge of the bar near the base of the projection, sometimes they are feebly marked; the anterior edge of the crossbar is prominent in the middle.

170 (171). The two small outgrowths at the posterior edge of the crossbar are connected with a posterior projection, forming two "windows."
D. scalpelliformis Gussev, 1955 (Fig. 270)

These are small worms; body can be up to 0.5 mm long and 0.12 mm wide. Length of marginal hooks is 0.025–0.043 mm. Length of anchors is 0.045–0.061 mm, main part 0.031–0.042 mm, inner root 0.017–0.023 mm, outer root 0.002–0.004 mm, point 0.019–0.023 mm. Size of dorsal bar is 0.005–0.007 x 0.038–0.049 mm, ventral bar 0.019–0.025 x 0.021–0.029 mm. Total length of copulatory organ is 0.054–0.070 mm. Vaginal armament is absent.

Found on gill filaments of *Chanodichthys mongolicus*, Amur River (Russia).

171 (170). The two small outgrowths at the posterior edge of the crossbar are not connected with a posterior projection.

172 (175). The copulatory tube is rather long (greater than 0.070 mm) and winding; it almost forms a ring or a loop.

173 (174). The copulatory tube is nearly cylindrical and winds along a ring; its length is greater than 0.090 mm; its diameter is slightly greater than 0.002 mm; the accessory piece forms a long and narrow muff surrounding the tube; the initial part of the tube has a projection.
D. proprius Gussev, 1955 (Fig. 271)

These are small worms; body can be up to 0.3 mm long and 0.08 mm wide. Length of marginal hooks is 0.023–0.029 mm. Length of anchors is 0.039–0.043 mm, main part 0.027–0.035 mm, inner root 0.015–0.017 mm, outer root 0.003–0.005 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.004 x 0.031–0.033 mm, ventral bar 0.010–0.012 x 0.020–0.025 mm. Total length of copulatory organ is 0.054–0.062, tube 0.094–0.100 mm.

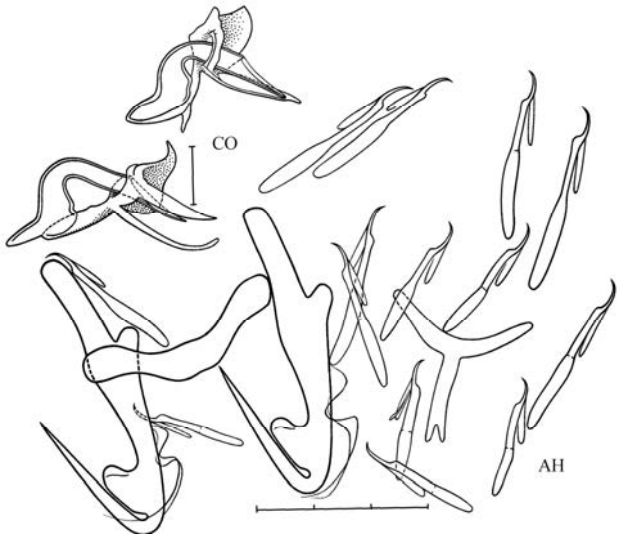
Found on gill filaments of *Hemiculter leucisculus*; Amur River (Russia); Liao He River (China).

174 (173). The copulatory tube tapers to its end and forms a loop; its length is less than 0.080 mm; its diameter in the middle part is greater than 0.001 mm; the posterior end of the accessory piece is claw shaped; the initial part of the tube lacks a projection.
D. tendiculus Gussev, 1955 (Fig. 272)

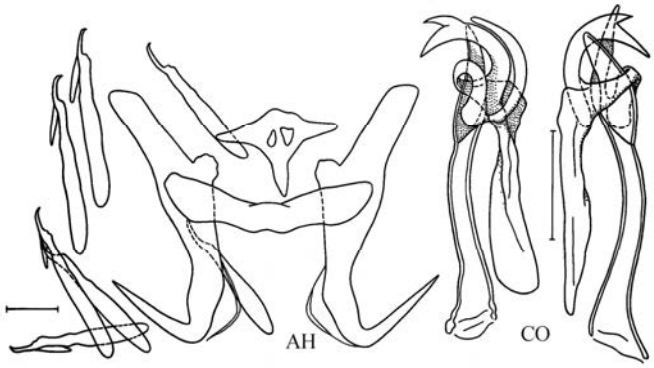
These are small worms; body can be up to 0.3 mm long and 0.05 mm wide. Length of marginal hooks is 0.019–0.026 mm. Length of anchors is 0.035–0.039 mm, main part 0.024–0.026 mm, inner root 0.012–0.015 mm, outer root 0.002 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.002–0.004 x 0.022–0.026 mm, ventral bar 0.012–0.016 x 0.013–0.016 mm. Total length of copulatory organ is 0.040–0.047 mm, tube 0.050–0.070 mm. Vaginal armament is absent.

Found on gill filaments of *Plagiognathops microlepis* and *Xenocypris macrolepis*; Lake Khanka (Russia).

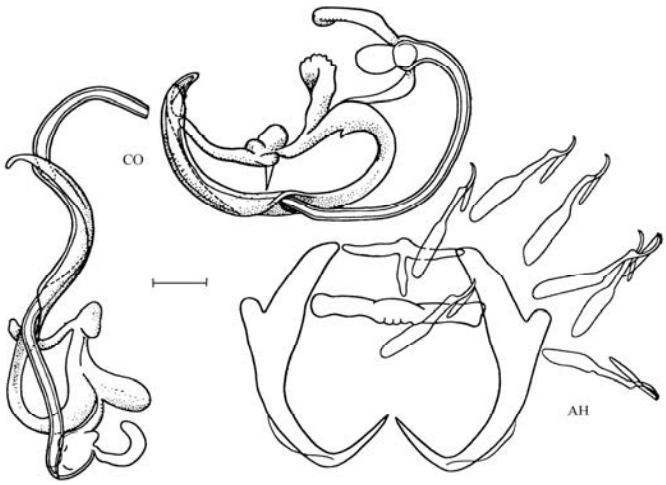
175 (172). The copulatory tube is weakly bent, **Г** or **C** shaped, or nearly straight; it is rather short (less than 0.070 mm long).



269

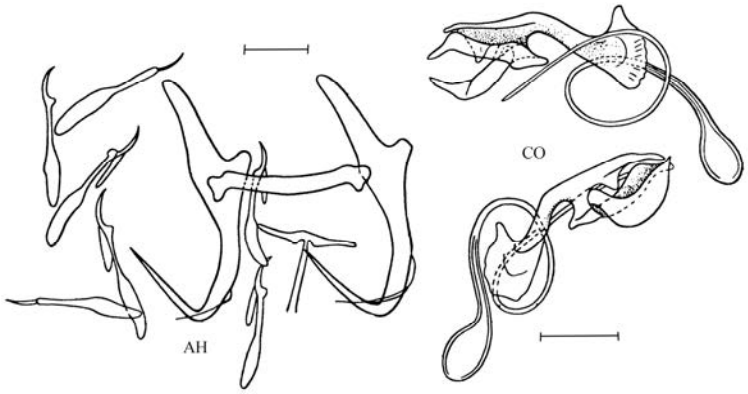


270

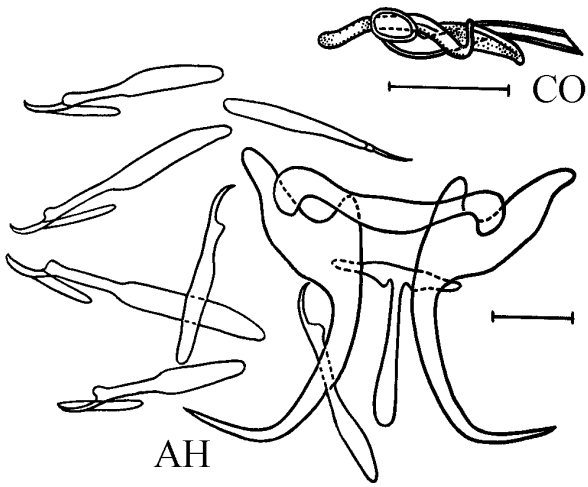


271

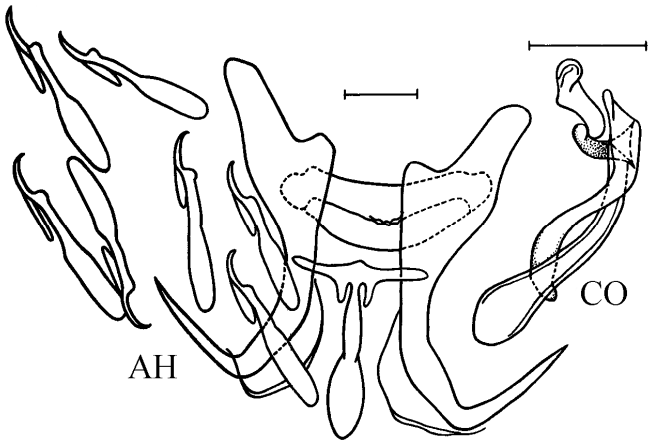
Fig. 269 – 271.
269 - *Dactylogyrus pterocleidus* (after Gussev, 1955a). **270 -** *Dactylogyrus scalpelliformis* from Lake Khanka, Russia (after Gussev, 1955a). **271 -** *Dactylogyrus proprius* (after Gussev, 1955a).



272



273



274

Fig. 272 – 274.
272 - *Dactylogyrus tendiculus* (after Gussev, 1955a). **273 -** *Dactylogyrus rimskykorsakowi* from *Plagiognathops microlepis* (after Gussev, 1955a). **274 -** *Dactylogyrus zalesskyi* (after Gussev, 1955a).

176 (179). The posterior projection of the ventral bar is long (greater than the length of its crossbar).

177 (178). The inner edge of the anchors' basal part is straightly cut.
D. rimskykorsakowi Gussev, 1955 (Fig. 273)

These are small worms; body can be up to 0.4 mm long and 0.08 mm wide. Length of marginal hooks is 0.021–0.031 mm. Length of anchors is 0.022–0.033 mm, main part 0.025–0.026 mm, inner root 0.010–0.012 mm, outer root about 0.004 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.004 x 0.027 mm, ventral bar 0.014–0.018 x 0.013–0.017 mm. Length of copulatory organ is about 0.020 mm, diameter 0.002 mm. Vaginal armament is absent.

Found on gill filaments of *Plagiognathops microlepis* and *Xenocypris macrolepis*; Amur River Basin (Russia).

178 (177). The inner edge of the anchors' basal part is usually smoothly rounded.
D. zalesskyi Gussev, 1955 (Fig. 274)

These are minute worms; body can be up to 0.3 mm long and 0.08 mm wide. Length of marginal hooks is 0.012–0.025 mm. Length of anchors is 0.040–0.043 mm, main part 0.030–0.033 mm, inner root 0.012–0.014 mm, outer root 0.002 mm, point 0.015–0.017 mm. Size of dorsal bar is 0.005–0.006 x 0.023–0.029 mm, ventral bar 0.017–0.021 x 0.016–0.020 mm. Length of copulatory tube is 0.022–0.030 mm, diameter 0.002 mm. Vaginal armament is absent.

Found on gill filaments of *Plagiognathops microlepis*; Amur River Basin (Russia).

179 (176). The posterior projection of the ventral bar is less than half the length of its crossbar.

180 (189). The copulatory tube is nearly cylindrical after the broadened initial part; the vaginal armament is absent.

181 (186). The diameter of the copulatory tube is greater than 0.003 mm.

182 (183). The diameter of the copulatory tube is greater than 0.006 mm. The length of the anchors is greater than 0.055 mm.
D. mongolicus Akhmerov, 1952 (Fig. 275)

These are large worms; body can be up to 1.5 mm long and 0.14 mm wide. Length of marginal hooks is 0.026–0.043 mm; the massive handle is not well delimited from the pivot and the heel of the point is not easily visible. Length of anchors is 0.056–0.062 mm, main part 0.040–0.043 mm, inner root 0.019–0.023 mm, outer root about 0.004 mm, point 0.023–0.025 mm. Size of dorsal bar is 0.007–0.012 x 0.046–0.049 mm, ventral bar 0.018 x 0.027–0.029 mm. Total length of copulatory organ is 0.068–0.083 mm; the end of the copulatory tube is scoop shaped and strongly bevelled.

Found on gill filaments of *Chanodichthys erythropterus*; Amur River Basin (Russia).

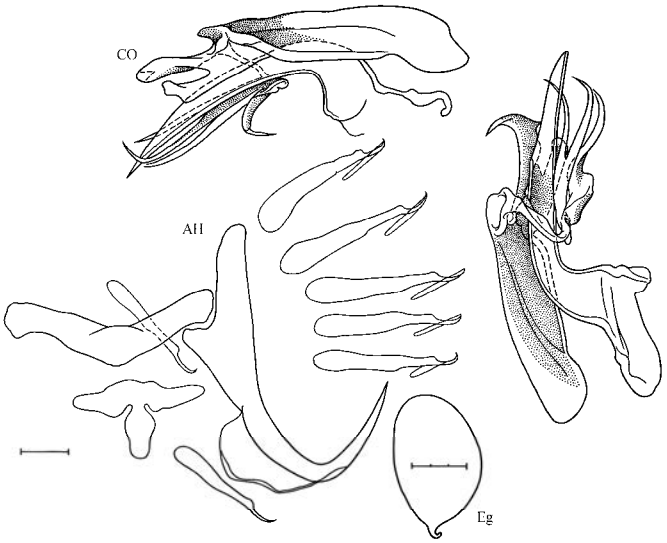
183 (182). The diameter of the copulatory tube is less than 0.005 mm. The length of the anchors is less than 0.050 mm.

184 (185). The posterior end of the accessory piece of the copulatory organ has 4–5 projections that surround the tube.
D. erythroculteris Gussev, 1955 (Fig. 276)

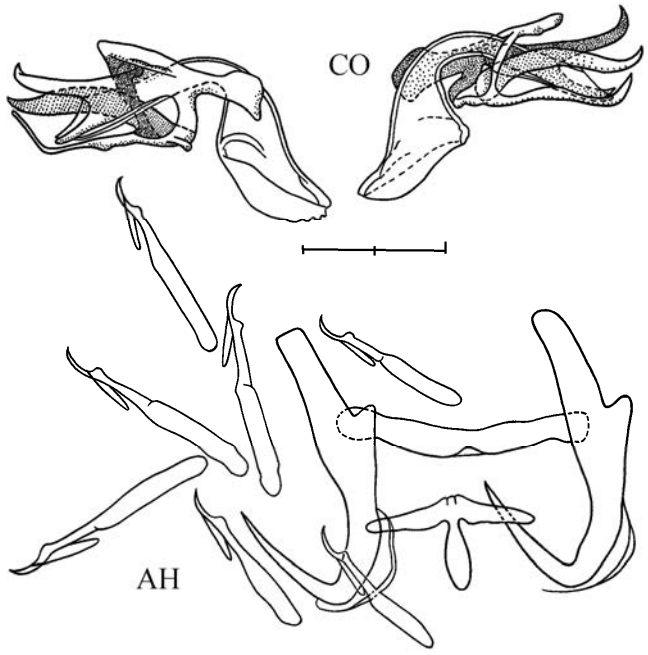
These are minute worms; body length is less than 0.3 mm, width 0.08 mm. The marginal hooks have a well-defined heel, pivot, and handle; their length is 0.019–0.041 (0.022–0.049)[56] mm.
Length of anchors is 0.036–0.050 mm, main part 0.023–0.029 mm, inner root 0.014–0.021 mm, outer root 0.002–0.004 mm, point 0.015–0.023 mm. Size of dorsal bar is 0.003–0.006 x 0.027–0.041 (0.045–0.049) mm, ventral bar 0.012–0.016 x 0.022–0.027 mm. Total length of copulatory organ is 0.043–0.050 mm; the end of the tube is beveled.

[56] Data in brackets are from Chen et al. (1973).

Found on gill filaments of *Chanodichthys oxycephalus, C. erythropterus, C. mongolicus*; Amur River Basin.



275



276

Fig. 275 – 276.
275 - *Dactylogyrus mongolicus* (after Gussev, 1955a). **276 -** *Dactylogyrus erythroculteris* (after Gussev, 1955a).

185 (184). The posterior end of the accessory piece of the copulatory organ is in the form of a bilobate bent fork that surrounds the tube.

D. strelkowi Gussev, 1955 (Fig. 277)

These are small worms; body can be up to 0.5 mm long and 0.12 mm wide. Length of marginal hooks is 0.020–0.039 (0.024–0.036)[57] mm. Length of anchors is 0.041–0.047 mm, main part 0.031–0.035 mm, inner root 0.012–0.016 mm, outer root 0.003–0.004 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.004–0.005 x 0.031–0.037 mm, ventral bar 0.010–0.013 x 0.020–0.025 mm. Length of copulatory organ is about 0.040 mm; the end of the copulatory tube is scoop shaped and strongly beveled.

Found on gill filaments of *Megalobrama skolkovii*; Amur River Basin (Russia). In Yangtze River (China) it is found on *Parabramis pekinensis*.

186 (181). The diameter of the copulatory tube is less than 0.0025 mm.

187 (188). The posterior end of the accessory piece of the copulatory organ is shaped like a broad gutter-like plate with a thin and bent projection that embraces the copulatory tube; the end of the tube is sidelong cut.

D. petruschewskyi Gussev, 1955 (Fig. 278)

These are small worms; body is about 0.5 mm long and 0.11 mm wide. Length of marginal hooks is 0.021–0.033 (0.016–0.032)[58] mm. Length of anchors is 0.041–0.047 (0.035–0.037) mm, main part 0.031 mm, inner root 0.013 mm, outer root 0.002–0.005 mm, point 0.013–0.015 (0.011–0.012) mm. Size of dorsal bar is 0.003–0.004 x 0.027–0.037 (0.024–0.027) mm, ventral bar 0.012–0.015 x 0.020–0.023 mm. Length of weakly bent copulatory tube is 0.020–0.023 mm.

Found on gill filaments of *Parabramis pekinensis* and *Megalobrama skolkovii*; Lake Khanka (Russia); Yangtze River (China).

188 (187). The posterior end of the accessory piece of the copulatory organ has three finger-shaped projections, one of which embraces the copulatory tube; the end of the tube is slightly bent.

D. tridigitatus Gussev, 1955 (Fig. 279)

These are small worms; length can be up to 0.40 mm, width 0.09 mm. Length of marginal hooks is 0.014–0.030 (0.010–0.026)[59] mm. Length of anchors is 0.024–0.033 mm, main part 0.018–0.024 mm, inner root 0.010–0.013 (0.007–0.008) mm, outer root 0.002–0.004, point 0.007–0.011 mm. Size of dorsal bar is 0.002–0.005 x 0.018–0.022 mm, ventral bar 0.008–0.010 x 0.014–0.017 mm. Total length of copulatory organ is 0.025–0.027 mm.

Found on gill filaments of *Hemiculter leucisculus* and *H. lucidus*; Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

189 (180). The copulatory tube tapers to its distal end; the vaginal armament may be present or absent.

190 (193). The copulatory tube is sickle shaped; the vaginal armament may be present or absent.

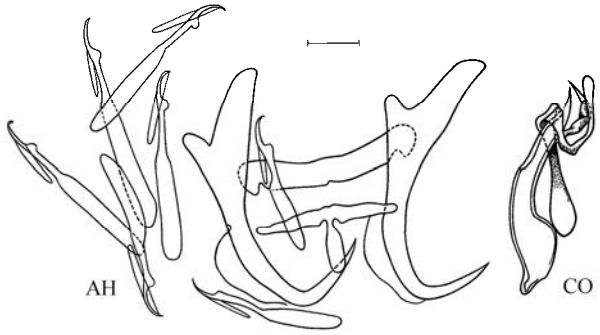
191 (192). The accessory piece of the copulatory organ in its posterior half becomes a muff that embraces the tube; a cymbiform broad plate departs from the muff; the initial part of the tube has a small fulcrate projection.

D. pellucidus Gussev, 1958 (Fig. 280)

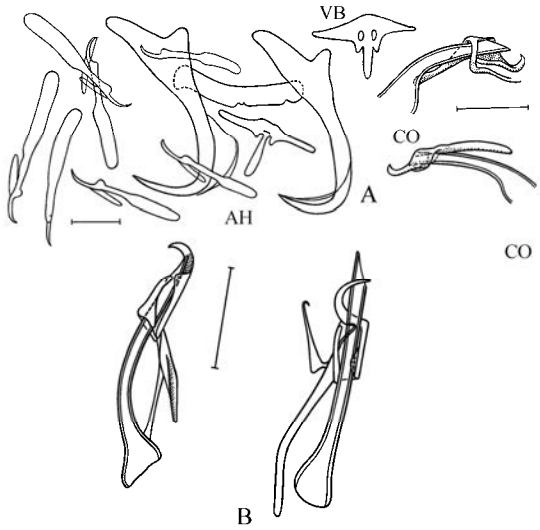
These are small worms; body can be up to 0.35 mm long and 0.08 mm wide. Length of marginal hooks is 0.015–0.026 mm. Length of anchors is 0.029–0.037 mm, main part 0.023–0.029 mm, inner root 0.008–0.011 mm, outer root 0.003 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.002–0.004 x 0.019–0.025 mm, ventral bar 0.007–0.017 x 0.017–0.020 mm. Total length of copu-

[57] Data in brackets are from Chen et al. (1973).
[58] Data in brackets are from Chen et al. (1973).
[59] Data in brackets are from Chen et al. (1973).

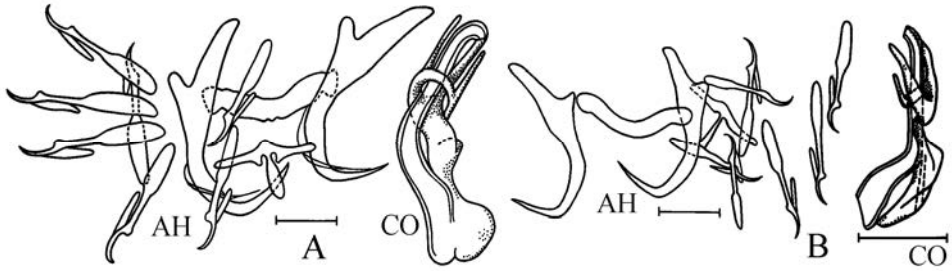
latory organ is 0.029–0.033 mm. Vaginal armament is absent.



277



278



279

Fig. 277 – 279.
277 - *Dactylogyrus strelkowi* (after Gussev, 1955a). **278 -** *Dactylogyrus petruschewskyi*: A – from *Parabramis pekinensis* (Lake Khanka, Russia) (after Gussev, 1955a), B – from Yangtze River (China) (after Chen et al., 1973). **279 -** *Dactylogyrus tridigitatus*: A – specimen from *Hemiculter lucidus*, B – specimen from *Hemiculter leucisculus* (after Gussev, 1955a).

Found on gill filaments of *Chanodichthys erythropterus* and *Culter alburnus*; Amur River Basin (Russia); Yangtze River (China).

192 (191). The accessory piece of the copulatory organ has several thin projections and one ribbon-like projection that embrace the tube; the initial part of the tube lacks fulcrate projections.
D. pannosus Gussev, 1955 (Fig. 281)

These are minute worms; body can be up to 0.3 mm long and 0.08 mm wide. Length of marginal hooks is 0.015–0.026 mm. Length of anchors is 0.028–0.033 mm, main part 0.019–0.020 mm, inner root 0.010–0.012 mm, outer root 0.002 mm, point 0.008–0.009 mm. Size of dorsal bar is 0.002–0.003 x 0.016–0.020 mm, ventral bar (length of crossbar) 0.015–0.017 mm; the posterior projection of the latter is poorly visible; this bar may be **T** shaped or have another shape. Total length of copulatory organ is 0.031–0.038 mm. The vaginal armament is like a bent tube; length about 0.030 mm, diameter 0.001 mm.

Found on gill filaments of Hemiculter leucisculus; Lake Khanka; Amur River (Russia).

193 (190). The copulatory tube is almost straight. The vaginal armament is present.

194 (195). The accessory piece of the copulatory organ is thin rachis-like in its proximal part; it forms a broad three-lobes plate in its distal part; this plate is folded in two along the longitudinal axis.
D. montschadskyi Gussev, 1955 (Fig. 282)

These are minute worms; body can be up to 0.32 mm long and 0.09 mm wide. Length of marginal hooks is 0.16–0.33 mm. Length of anchors is 0.030–0.037 mm, inner root 0.008–0.013 mm, outer root 0.002–0.003 mm, point 0.014–0.016 mm. Size of dorsal bar is 0.003–0.004 x 0.023–0.027 mm, ventral bar 0.009–0.012 x 0.015–0.021 mm. Length of copulatory organ is 0.029–0.035 mm. Vaginal armament is a straight tube; length about 0.012 mm.

Found on gill filaments of *Culter alburnus*; Amur River Basin (Russia); Yangtze River (China).

195 (194). The accessory piece of the copulatory organ is in the form of a plate with broadened ends and a pinch in the middle; it has a long thin bending projection in the middle that embraces the tube.

196 (197). The total length of the copulatory organ is less than 0.040 mm.
D. parabramis Akhmerov, 1952 (Fig. 283)

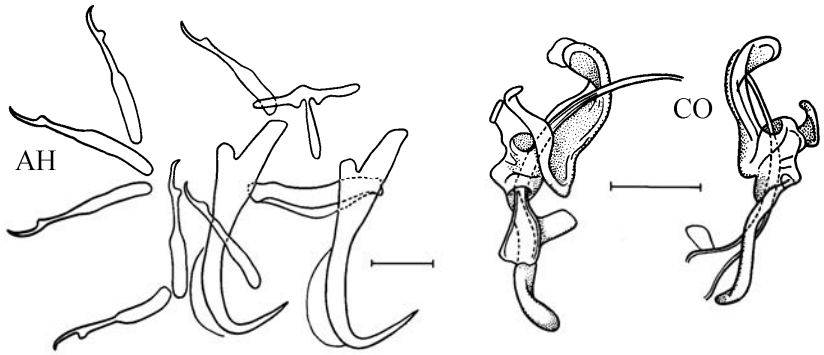
These are small worms; body can be up to 0.45 mm long and 0.13 mm wide. Length of marginal hooks is 0.018–0.038 mm. Length of anchors is 0.038–0.049 (0.027–0.040)[60] mm, main part 0.027–0.036 mm, inner root 0.014–0.016 mm, outer root 0.002–0.004 mm, point 0.011–0.015 mm. Size of dorsal bar is 0.002–0.004 x 0.021–0.035 mm, ventral bar 0.010–0.014 x 0.017–0.023 mm. Total length of copulatory organ is 0.031–0.037 mm. Length of bent vaginal tube is 0.013–0.020 mm.

Found on gill filaments of *Parabramis pekinensis* and *Megalobrama skolkovii* (?); Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

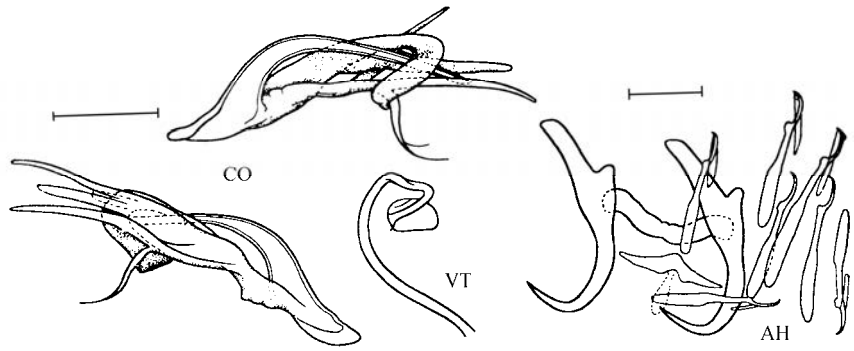
197 (196). The total length of the copulatory organ is greater than 0.045 mm.
D. pekinensis Gussev, 1955 (Fig. 284)

These are small worms; body can be up to 0.55 mm long and 0.11 mm wide. Length of marginal hooks.

[60] Data in brackets are from Chen et al. (1973).

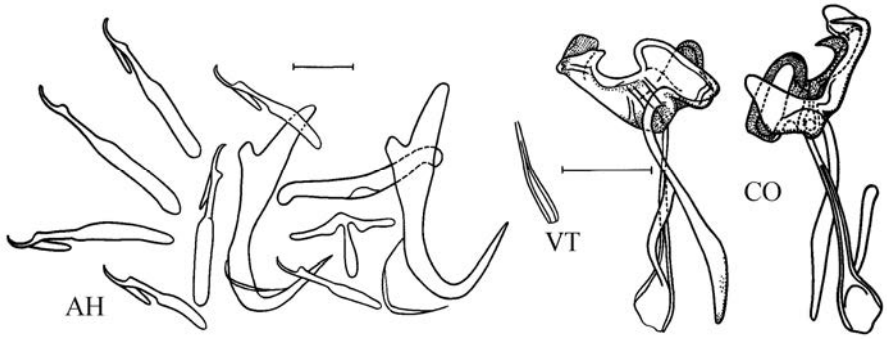


280

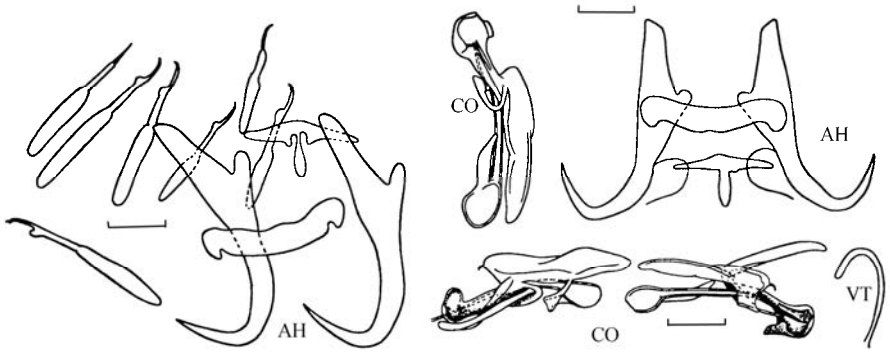


281

Fig.280-281
280 - *Dactylogyrus pellucidus* (after Gussev, 1955a). **281 -** *Dactylogyrus pannosus* (after Gussev, 1955a).

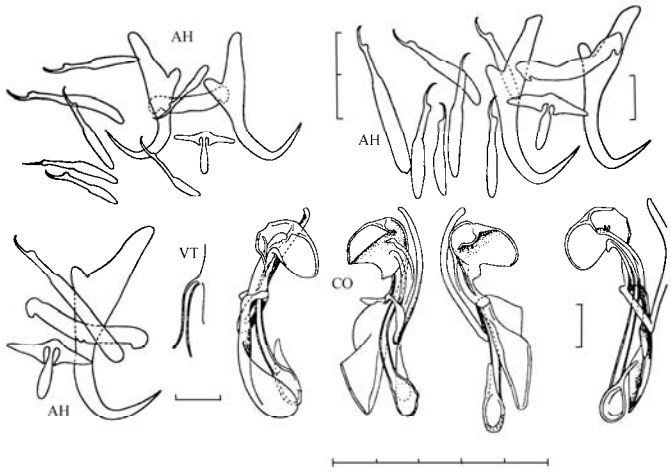


282

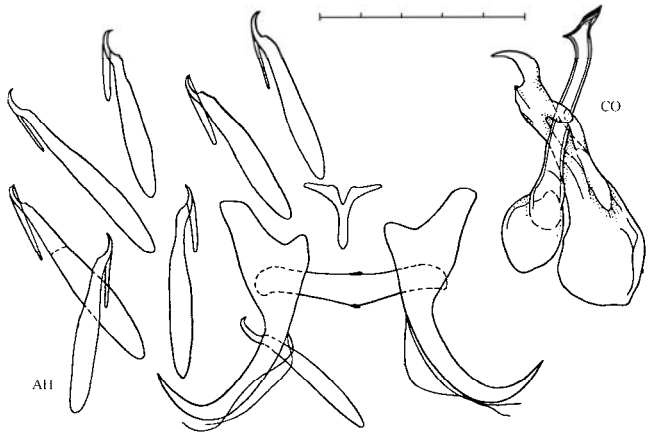


283

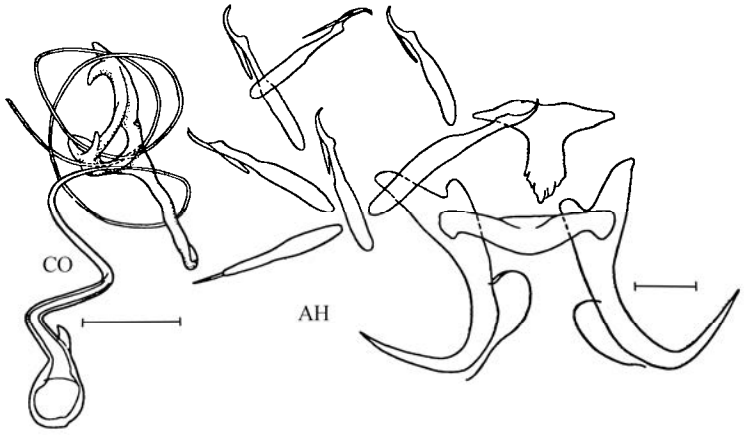
Fig. 282 – 283.
282 - *Dactylogyrus montschadskyi* (after Gussev, 1955a). **283 -** *Dactylogyrus parabramis* (after Gussev, 1955a, 1962).



284



285



286

Fig. 284 – 286.
284 - *Dactylogyrus pekinensis* (after Gussev, 1955a, 1962). **285 -** *Dactylogyrus peltatus* (after Gussev, 1955a, 1962). **286 -** *Dactylogyrus flagellicirrus* (after Gussev, 1955a, 1962).

0.017–0.043 mm. Length of anchors is 0.030–0.045 mm, main part 0.019–0.033 mm, inner root 0.012–0.019 mm, outer root 0.003–0.005 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.002–0.005 x 0.019–0.035 mm, ventral bar 0.010–0.015 x 0.016–0.025 mm. Total length of copulatory organ is 0.045–0.055 mm. Length of vaginal tube is about 0.020 mm.

Found on gill filaments of ***Parabramis pekinensis*** and ***Megalobrama skolkovii***; Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

198 (169). The posterior projection of the ventral bar is rachis-like or wedge shaped; the posterior edge of the bar lacks two small outgrowths near the base of the projection; its anterior edge has a dent in the middle.

199 (200). The copulatory tube is almost straight and is rather broad; its diameter is greater than 0.03 mm in the middle; the posterior end broadens and forms a funnel; the accessory piece is shield shaped and is as long as the tube, with a claw-shaped end and two finger-shaped projections in its middle part that embrace the tube. The marginal hooks are very rough. The vaginal armament is absent.

D. peltatus Gussev, 1955 (Fig. 285)

These are small or medium size worms; body can be up to 0.6 mm long and 0.12 mm wide. Marginal hooks have a handle that is poorly bordered from the pivot; heel of the point is smooth; the hooks length is 0.032–0.055 mm. Length of anchors is 0.045–0.053 mm, main part 0.042–0.046 mm, inner root 0.012–0.016 mm, outer root 0.003–0.005 mm, point 0.010–0.013 mm. Size of dorsal bar is 0.005–0.007 x 0.039–0.046 mm, ventral bar 0.012–0.018 x 0.015–0.021 mm. Length of copulatory organ is 0.043–0.068 mm; the copulatory tube and its accessory piece are the same length.

Found on gill filaments of ***Culter alburnus***; Amur River Basin (Russia); in Yangtze River (China) it is found also on ***Chanodichthys erythropterus***.

200 (199). The copulatory tube is thin and forms a spiral or a loop; its diameter is less than 0.001 mm in the middle; the posterior end does not broaden; the accessory piece is bifurcated and it is much shorter than the tube. The marginal hooks are slender and their parts are well differentiated. The vaginal armament is present.

201 (202). The length of the copulatory tube is about 0.14 mm; the accessory piece is straight and bifurcated; the bubble-shaped initial part of the tube has a fulcrate projection.

D. flagellicirrus Gussev, 1955 (Fig. 286)

These are small worms; body can be up to 0.43 mm long and 0.09 mm wide. Length of marginal hooks is 0.019–0.034 mm. Length of anchors is 0.029–0.032 mm, main part 0.024–0.027 mm, inner root 0.008–0.010 mm, outer root 0.002–0.004 mm, point 0.012–0.014 mm. Size of dorsal bar is 0.004–0.006 x 0.022–0.027 mm, ventral bar 0.012–0.015 x 0.019–0.021 mm. Length of thread-shaped twisting copulatory tube along the curve is 0.13–0.15 mm, accessory piece 0.022–0.025 mm. Vaginal armament is a thin twisted tube with a length of about 0.09 mm; its end is bubble-like.

Found on gill filaments of ***Culter alburnus*** and ***Chanodichthys erythropterus***; Amur River Basin (Russia); Yangtze River (China).

202 (201). The length of the copulatory tube is less than 0.08 mm. The handle of the bifurcated accessory piece is long, bent, and two times shorter than the tube. One of its branches forms a gutter within which the tube runs; the copulatory organ is of the "triaxonis" type.

203 (204). The anchor roots are widely separated, with an angle of about 70° between their axes; the ventral bar has a pointed projection and a dent on the anterior edge of its crossbar.

D. triaxonis Akhmerov, 1952 (Fig. 287)

These are small worms; body can be up to 0.56 mm long and 0.12 mm wide. Length of marginal hooks is

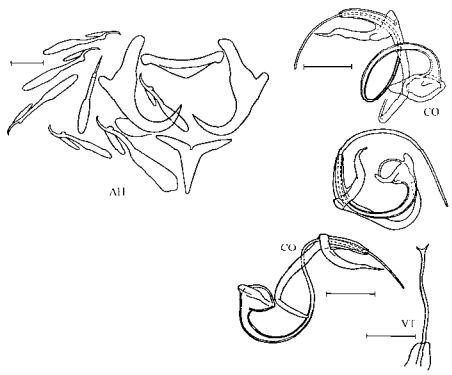
0.017–0.030 mm. Length of anchors is 0.025–0.034 mm, main part 0.018–0.026 mm, inner root 0.010–0.016 mm, outer root 0.003–0.004 mm, point 0.008–0.010 (0.004–0.006)61 mm. Size of dorsal bar is 0.003–0.005 x 0.022–0.026 mm, ventral bar 0.012–0.015 x 0.019–0.025 (0.021–0.030 x 0.028–0.031) mm. Length of copulatory tube is 0.060–0.074 mm, accessory piece 0.032–0.042 mm, total length of copulatory organ 0.025–0.035 mm. Length of vaginal tube is 0.020–0.026 mm.

Found on gill filaments of *Acanthorhodeus asmussi*; Amur River Basin (Russia). Found in Liao He River (China) on *Acheilognathus chankaensis*.

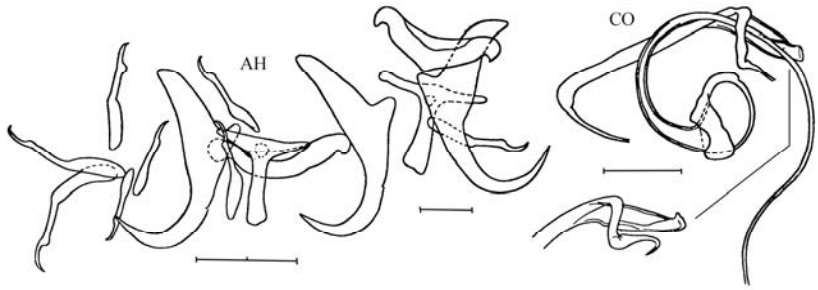
204 (203). The anchor roots have an angle of 45–50° between their axes; the ventral bar has a convex anterior edge and a projection that broadens posteriorly.

D. liaohoensis Gussev, 1962 (Fig. 288)

These are small worms; body can be up to 0.4 mm long and 0.10 mm wide. Length of marginal hooks is 0.017–0.027 mm. Length of anchors is 0.035–0.039 mm, main part 0.026–0.030 mm, inner root 0.015–0.017 mm, outer root 0.002–0.003 mm, point 0.010–0.011 mm. Size of dorsal bar is 0.004–0.007 x 0.025–0.031 mm, ventral bar 0.016–0.019 x 0.019–0.021 mm. Copulatory organ and vaginal armament are similar to those of *D. triaxonis*.



287



288

Fig. 287 – 288.
287 - *Dactylogyrus triaxonis* (after Gussev, 1955a, 1962). **288 -** *Dactylogyrus liaohoensis* (after Gussev, 1955a, 1962).

[61] Data in brackets are from Chen et al. (1973).

Found on gill filaments of *Acheilognathus chankaensis*; Liao He River (China); probably will be found in Russian water bodies.

205 (166). The posterior projection of the ventral bar is less than half the length of the crossbar, and sometimes it is poorly visible; it can be better seen only on very pressed specimens; this bar looks like a flying bird.

206 (209). The ventral bar is **V** shaped, thin, and small (two times smaller than the dorsal bar in "wing-span").

207 (208). The copulatory tube is very thin; its diameter in the middle is less than 0.001 mm; the accessory piece is a simple narrow plate without projections and with a claw-shaped end.
D. chenminjungue Gussev, 1962 (Fig. 289)

These are small or medium size worms; body can be up to 0.7 mm long and 0.15 mm wide. Length of marginal hooks is 0.021–0.029 mm. Length of anchors is 0.044–0.054 mm, main part 0.035–0.043 mm, inner root 0.012–0.019 mm, outer root 0.001–0.003 mm, point 0.019–0.023 mm. Size of dorsal bar is 0.004–0.006 x 0.021–0.031 mm, ventral bar 0.003 x 0.013 – 0.017 mm. Length of copulatory organ is 0.045–0.051 mm. Vaginal armament is funnel shaped.

Found on gill filaments of *Chanodichthys erythropterus*; Liao He River (China). Found also on *Culter alburnus* in the Yangtze River (China); probably will be found in Russian water bodies.

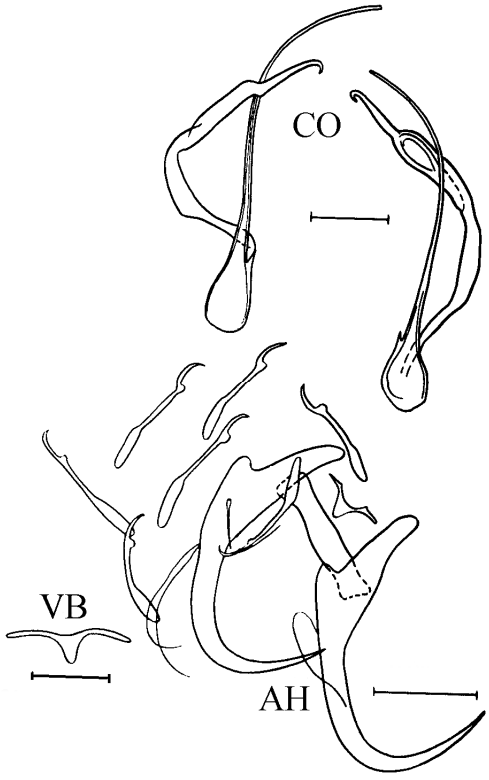


Fig. 289 - *Dactylogyrus chenminjungue* (after Gussev, 1962).

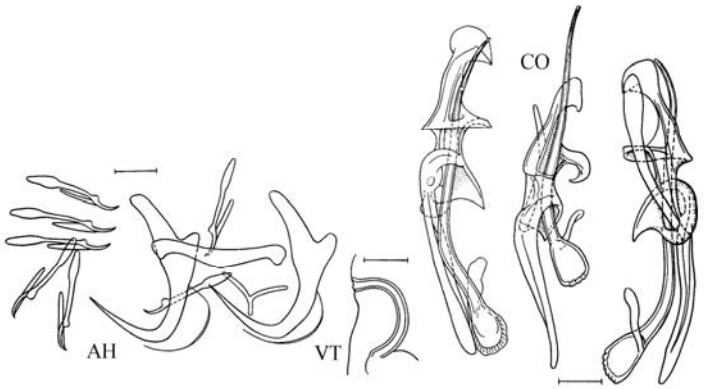
208 (207). The copulatory tube is rather broad; its diameter is greater than 0.002 mm; the accessory piece is of a more complicated structure; a pinch and a muff surround the tube in its middle; its posterior end resembles a bird's head.
D. kurenkovi Gussev, 1955 (Fig. 290)

These are small or medium size worms; body can be up to 0.7 mm long and 0.14 mm wide. Length of marginal hooks is 0.017–0.025 mm. Length of anchors is 0.024–0.032 mm, main part 0.019–0.023 mm, inner root 0.010–0.014 mm, outer root 0.002–0.004 mm, point 0.013–0.018 mm. Size of dorsal bar is 0.003–0.005 x 0.025–0.034 mm, ventral bar 0.003–0.007 x 0.012–0.018 mm. Length of copulatory tube and its accessory piece is 0.062–0.074 mm. Vaginal tube is short, bent, and about 0.027 mm long, diameter 0.002 mm.

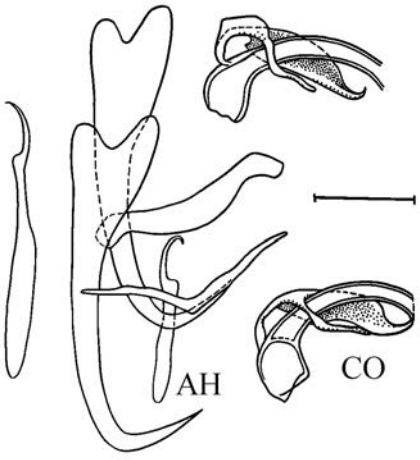
Found on gill filaments of *Opsariichthys bidens*; Amur River Basin (Russia); Liao He and Yangtze Rivers (China).

209 (206). The ventral bar is almost straight or slightly bent backwards; its length in "wing-span" is greater than half the length of the dorsal bar.

210 (211). The inner root of the anchors is short (less than 1.5 times longer than the outer root).
D. laymanianus Gussev, 1955 (Fig. 291)



290



291

Fig. 290 – 291.
290 - *Dactylogyrus kurenkovi* (after Gussev, 1955a). **291 -** *Dactylogyrus laymanianus* (after Gussev, 1955a).

These are minute worms; body can be up to 0.3 mm long and 0.07 mm wide. Length of marginal hooks is 0.015–0.026 mm. Length of anchors is about 0.31 mm, main part 0.027 mm, inner root 0.004–0.005 mm, outer root 0.003 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.003 x 0.020–0.023 mm, ventral bar (slightly bent backwards with a short posterior projection) 0.002–0.003 x 0.021 mm. Length of bent copulatory tube is 0.020–0.021, diameter 0.002–0.0025 mm; the accessory piece is fork shaped ("triaxonis" type). Vaginal armament is absent.

Found on gill filaments of *Sarcocheilichthys czerskii*; Mo River (Lake Khanka Basin, Russia).

211 (210). The inner root of the anchors is long (greater than 2.5 times longer than the outer root).

212 (223). The copulatory tube is short (less than 0.040 mm long); diameter in the middle part can be up to 0.0025 mm long.

213 (216). The accessory piece of the copulatory organ is of the "triaxonis" type but with a short handle. These are parasites of *Squalidus chankaensis*.

214 (215). The length of the anchors is about 0.025 mm; the inner root is four times longer than the outer root. The length of the copulatory tube is less than 0.022 mm.
D. gnathopogonis Yamaguti, 1963 (Fig. 292)
Syn.: *D. dubius* Gussev, 1955 n. praeocc.

These are small worms; body can be up to 0.33 mm long and 0.08 mm wide. Length of marginal hooks is 0.014–0.023 mm. Length of anchors is 0.025–0.026 mm, main part 0.018–0.020 mm, inner root about 0.008 mm, outer root 0.001–0.002 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.002 x 0.020 mm, ventral bar 0.004 x 0.016 mm. Length of copulatory tube is 0.020–0.022 mm. Vaginal armament is absent.

Found on gill filaments of Squalidus chankaensis; Mo River (Lake Khanka Basin, Russia).

215 (214). The length of the anchors is about 0.030 mm; the inner root is three times longer than the outer root. The copulatory tube is greater than 0.023 mm long.
D. zachvatkini Gussev, 1955 (Fig. 293)

These are minute worms; body length can be up to 0.25 mm, width 0.07 mm. Length of marginal hooks is 0.016–0.027 mm. Length of anchors is 0.029–0.033 mm, main part 0.025–0.027 mm, inner root 0.006–0.010 mm, outer root 0.003–0.004 mm, point about 0.010 mm. Size of dorsal bar is 0.002–0.004 x 0.021–0.023 mm, ventral bar 0.003–0.006 x 0.018–0.020 mm. Length of copulatory tube is 0.023–0.033 mm. Vaginal armament is absent.

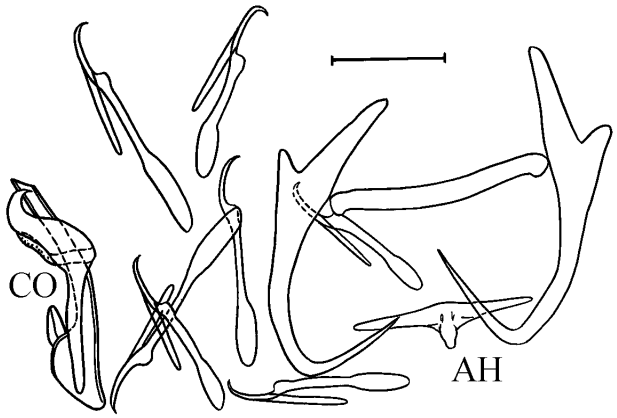
Found on gill filaments of *Squalidus chankaensis*; Lake Khanka (Russia); Liao He River (China).

216 (213). The accessory piece of the copulatory organ is of another type. These are parasites of different fishes.

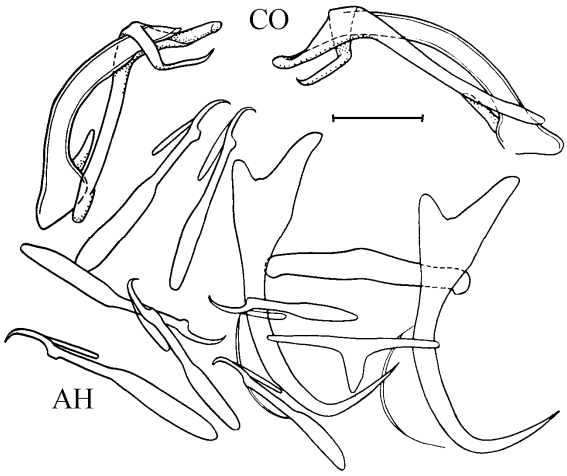
217 (220). The accessory piece is like a broad plate with folds.

218 (219). The accessory piece is triangular with a gutter at one side for the copulatory tube and with a rachis-like proximal handle.
D. clypeatus Gussev, 1955 (Fig. 294)

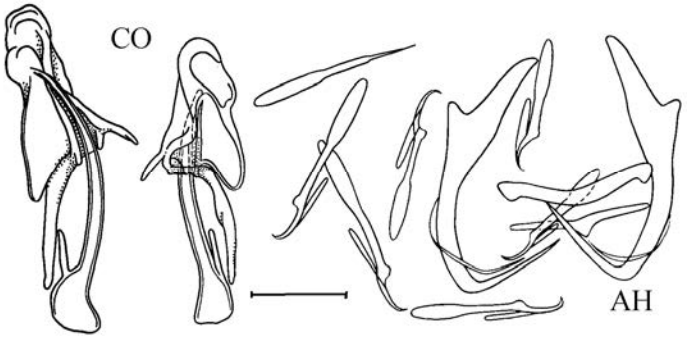
These are minute worms; body can be up to 0.26 mm long and 0.06 mm wide. Length of marginal hooks is 0.015–0.032 mm. Length of anchors is 0.022–0.025 mm, main part 0.012–0.018 mm, inner root 0.007–0.010 mm, outer root 0.001–0.002 mm, point 0.009–0.013 mm. Size of dorsal bar is about 0.002 x 0.016–0.023 mm, ventral bar 0.004–0.005 x 0.021–0.023 mm. Total length of copulatory organ is 0.022–0.036 mm. Vaginal armament is absent.



292



293



294

Fig. 292 – 294.
292 - *Dactylogyrus gnathopogonis* (after Gussev, 1955a). **293 -** *Dactylogyrus zachvatkini* (after Gussev, 1955a).
294 - *Dactylogyrus clypeatus* (after Gussev, 1955a).

Found on gill filaments of *Squalidus chankaensis*; Amur River Basin (Russia); Liao He River (China).

219 (218). The accessory piece of the copulatory organ is muff shaped and surrounds the copulatory tube.

D. fragilis Gussev, 1955 (Fig. 295)

These are small worms; body can be up to 0.4 mm long and 0.07 mm wide. Length of marginal hooks is 0.020–0.028 mm. Length of anchors is 0.039–0.052 mm, main part 0.027–0.032 mm, inner root 0.013–0.021 mm, outer root about 0.002 mm, point 0.013–0.017 mm. Size of dorsal bar is 0.004–0.005 x 0.025–0.033 mm, ventral bar 0.006–0.007 x 0.018–0.023 mm. Length of weakly **S**-bent copulatory tube is 0.033–0.037 mm. Vaginal armament is absent.

Found on gill filaments of *Chanodichthys mongolicus*; Amur River Basin (Russia).

220 (214). The accessory piece of the copulatory organ is rachis-like and has a projections at the end.

221 (222). The copulatory tube is **S** shaped; the accessory piece forms a ring around the tube and has two projections. The longest marginal hooks are longer than the anchors.

D. hypophthalmichthys Akhmerov, 1952 (Fig. 296)

These are small worms; body can be up to 0.52 mm long and 0.12 mm wide. Length of marginal hooks is 0.019–0.046 mm. Length of anchors is 0.025–0.035 mm, main part 0.022–0.031 mm, inner root 0.010–0.013 mm, outer root 0.004–0.006 mm, point 0.002–0.005 mm (the most small point!). Size of dorsal bar is 0.003–0.006 x 0.023–0.031 mm, ventral bar 0.008–0.010 x 0.029–0.040 mm. Total length of copulatory organ is 0.029–0.037 mm. Vaginal armament is absent.

Found on gill filaments of *Hypophthalmichthys molitrix*; Amur River Basin (Russia); Liao He and Yangtze Rivers (China); also found in all fish farms and water bodies of the Palaearctic where its host has been introduced.

222 (221). The copulatory tube is sickle shaped; the accessory piece has three projections at the end that surrounds the tube. The marginal hooks are shorter than the anchors.

D. pusillus Gussev, 1955 (Fig. 297)

These are small worms; body is less than 0.3 mm long and 0.05 mm wide. Length of marginal hooks is 0.014–0.025 mm. Length of anchors is 0.027–0.029 mm, main part 0.018–0.020 mm, inner root about 0.010 mm, outer root 0.001–0.003 mm, point 0.011–0.013 mm. Size of dorsal bar is 0.002 x 0.017–0.021 mm, ventral bar 0.006–0.008 x 0.010–0.017 mm. Total length of copulatory organ is 0.014–0.016 mm, copulatory tube 0.025–0.027 mm. Vaginal armament is absent.

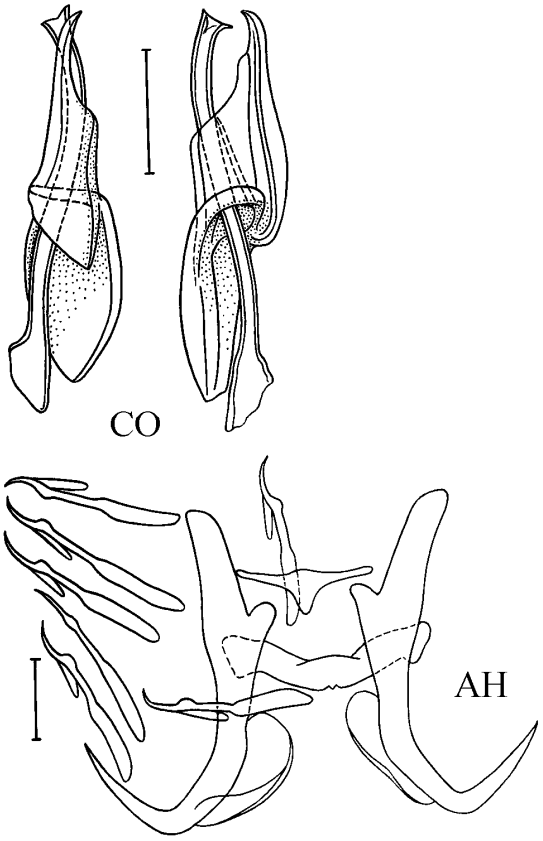
Found on gill filaments of *Hemiculter leucisculus* and *H. lucidus*; Amur River Basin (Russia); Liao He River (China).

223 (212). The copulatory tube is rather long (greater than 0.050 mm); its diameter is greater than 0.003 mm.

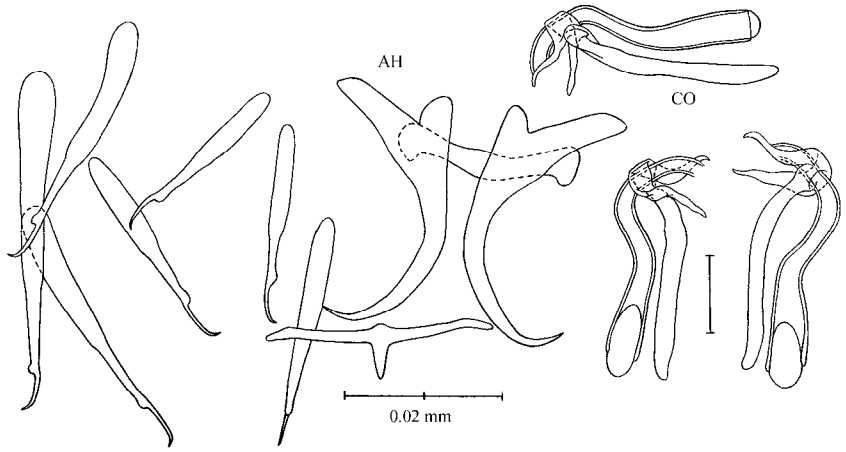
224 (225). The copulatory tube is **S** shaped with a thickened edge of the initial part; the accessory piece is a simple rachis-like plate with a bifurcation at its end.

D. ctenopharyngodonis Akhmerov, 1952 (Fig. 298)

These are small worms; body can be up to 0.5 mm long and 0.10 mm wide. Length of marginal hooks is 0.026–0.040 mm. Length of anchors is 0.039–0.053 mm, main part 0.030–0.041 mm, inner root 0.012–0.014 mm, outer root 0.005–0.006 mm, point 0.016–0.020 mm. Size of dorsal bar is 0.004–0.006 x 0.031–0.038 mm, ventral bar 0.003–0.005 x 0.023–0.032 mm. Total length of copulatory organ is 0.050–0.056 mm, length of copulatory tube 0.055–0.063 mm. Vaginal armament is absent.



295

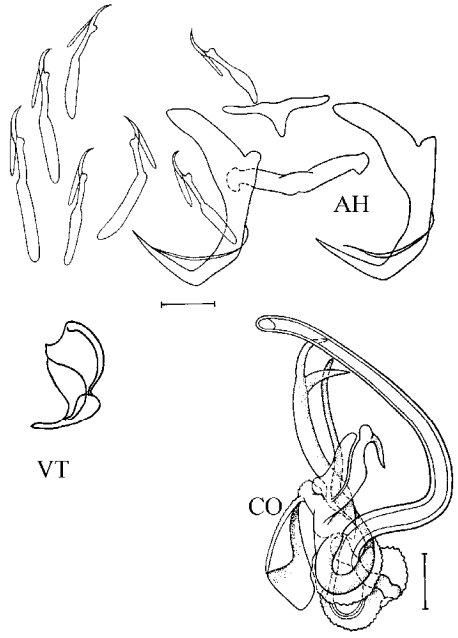


296

Fig. 295 – 296.
295 - *Dactylogyrus fragilis* (after Gussev, 1955a). **296 -** *Dactylogyrus hypophthalmichthys*.

297

298



299

Fig. 297 – 299.
297 - *Dactylogyrus pusillus* (after Gussev, 1955a). **298 -** *Dactylogyrus ctenopharyngodonis.***299 -** *Dactylogyrus floricirrus* (after Gussev, 1955a, VT – after Tchang, 1966).

Found on gill filaments of *Ctenopharyngodon idella*; Amur River Basin (Russia); Liao He and Yangtze Rivers (China); also found in all fish farms and water bodies of the Palaearctic where its host was introduced.

225 (224). The copulatory tube is sickle shaped and has a massive outgrowth on its initial part; the accessory piece looks like a bush.
D. floricirrus Gussev, 1955 (Fig. 299)

These are small worms; body can be up to 0.6 mm long and 0.09 mm wide. Length of marginal hooks is 0.016–0.029 mm. Length of anchors is 0.031–0.037 mm, main part 0.024–0.027 mm, inner root 0.012–0.015 mm, outer root 0.002–0.003 mm, point 0.012–0.015 mm. Size of dorsal bar is 0.003–0.006 x 0.026–0.029 mm, ventral root 0.006–0.008 x 0.019–0.023 mm. Total length of copulatory organ is 0.054–0.064 mm, length of copulatory tube along the curve 0.074–0.090 mm, diameter of its middle part 0.004–0.005 mm. The vaginal armament is triangular with thin walls.

Found on gill filaments of *Chanodichthys mongolicus*; Lake Khanka (Russia).

Supplement to species of *Dactylogyrus* from the Amur region

I. Key to species of *Dactylogyrus* found on gills of *Squaliobarbus curriculus* in China's Sungari, Liao He, and Yangtze Rivers[62]

1 (4). The anchors are large (greater than 0.075 mm) and 4–5 times longer than the marginal hooks. Only a dorsal bar is present (the ventral bar is absent).

2 (3). The anchors have a linguiform projection near the point (of the "pterocleidus" type).
D. knobihamatus Ling, 1973 (Fig. 300)

These are medium size worms; body can be up to 0.74 mm long and 0.13 mm wide. Length of marginal hooks is 0.018–0.024 mm. Length of anchors is 0.075–0.081 mm, inner root 0.029–0.034 mm, outer root 0.010–0.013 mm, point 0.034–0.037 mm. Size of dorsal bar is 0.003–0.005 x 0.024–0.032 mm. Length of copulatory tube is 0.035–0.048 mm, accessory piece 0.032–0.046 mm.

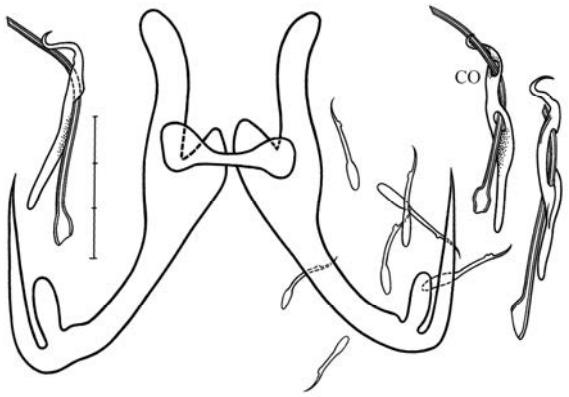
3 (2). The anchors lack a projection near the point.
D. longsoi Gussev, 1962 (Fig. 301)

These are medium or large worms; body can be up to 1.2 mm long and 0.14 mm wide. Length of marginal hooks is 0.018–0.029 mm. Length of anchors is 0.096–0.115 mm, main part 0.077–0.087 mm, inner root 0.029–0.037 mm, outer root 0.006–0.010 mm, point 0.024–0.030 mm. Size of dorsal bar is 0.007–0.011 x 0.029–0.037 mm. Length of copulatory tube is 0.057–0.075 mm. Diameter of vaginal "bubble" is 0.010–0.015 mm.

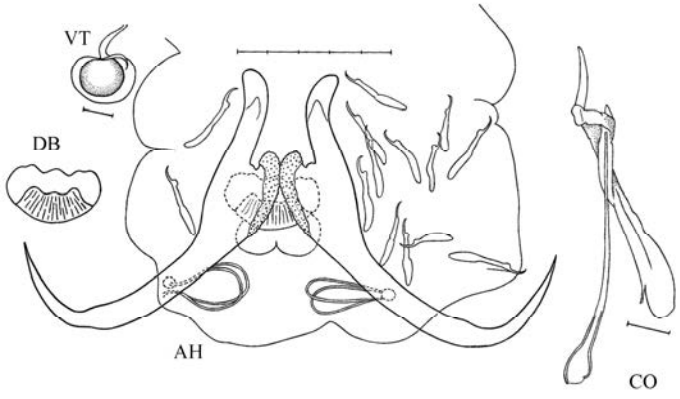
4 (1). The length of the anchors is less than 0.055 mm; they are less than 1.5–2.5 times longer than the marginal hooks. Both dorsal and ventral bars are present.

5 (18). The ventral bar is ribbon or stick shaped, almost straight or slightly bent, and broader in the middle.

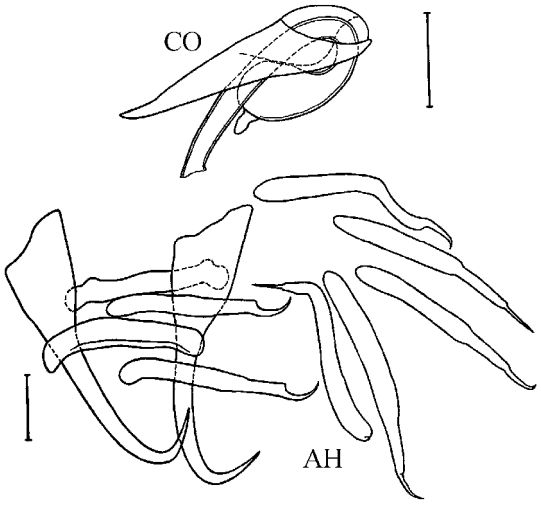
[62] These species have been excluded from the identification key of Amur River species of the genus *Dactylogyrus* because they and their host do not live in the Amur River and only occasionally can be caught there migrating from the Sungari River.



300



301



302

Fig. 300 – 302.
300 - *Dactylogyrus knobihamatus* (after Chen et al., 1973). **301 -** *Dactylogyrus longsoi* (after Gussev, 1962).
302 - *Dactylogyrus duplus* (after Gussev, 1955b).

6 (17). The handle of the rough marginal hooks is only slightly delimited from the pivot and the heel of the point is smooth; the hooks are rather long and slightly shorter than the anchors. The anchors are of the "nanus" type, with an almost straight main part and small roots; the inner root is less than 2–2.5 times longer than the outer root and 5–6 times shorter than the main part. The copulatory tube is sickle or **Γ** shaped.

7 (14). The copulatory tube is broad, almost cylindrical, except for the broadened initial part; the vaginal armament is absent.

8 (11). The accessory piece of the copulatory organ has a leaf-shaped posterior part.

9 (10). The anchors lack an outer root; length of the anchors is 0.034–0.045 mm, marginal hooks 0.028–0.038 mm. The copulatory tube lacks a broadening at its end.
D. duplus Gussev, 1955 (Fig. 302)

These are small worms; body can be up to 0.5 mm long and 0.11 mm wide. Length of main part of anchors is 0.032–0.040 mm, inner root 0.004–0.006 mm, point 0.008–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.022–0.025 mm, ventral bar 0.004 x 0.025–0.029 mm. Total length of copulatory organ is 0.030–0.034, bent tube 0.050–0.060 mm.

10 (9). The anchors have a very small outer root that is 0.030–0.038 mm long; marginal hooks 0.019–0.039 mm. The copulatory tube is broadened at its end.
D. mantschuricus Gussev, 1962 (Fig. 303)
Syn.: *D. duplus* Gussev, 1955, part.

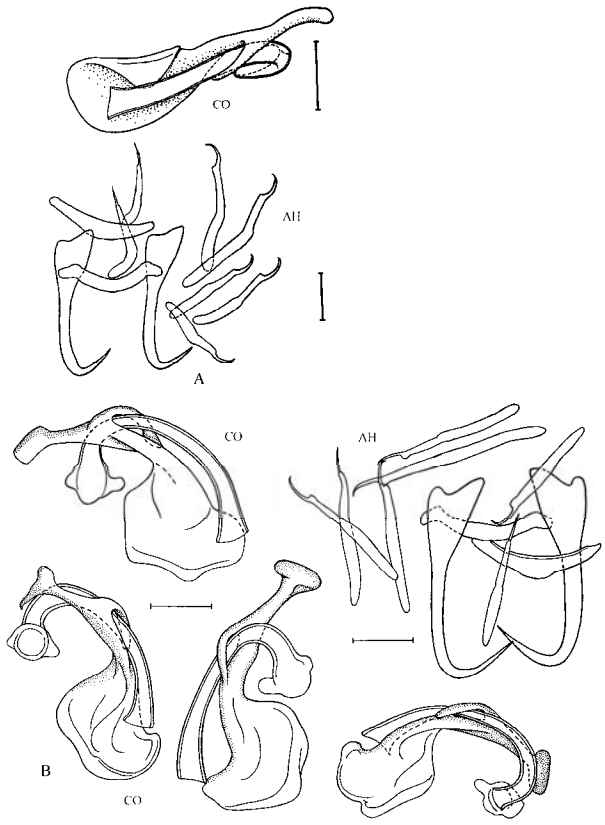


Fig. 303 - *Dactylogyrus mantschuricus*
A – after Gussev, 1955a, B – after Gussev, 1962.

These are small worms; body can be up to 0.5 mm long and 0.09 mm wide. Length of main part of anchors is 0.029–0.033 mm, inner root 0.004–0.007 mm, outer root 0.001–0.003 mm, point 0.008–0.014 mm. Size of dorsal bar is 0.002–0.003 x 0.020–0.027 mm, ventral bar 0.003–0.005 x 0.020–0.029 mm. Total length of copulatory organ is 0.035–0.045 mm, copulatory tube 0.039–0.048 mm.

11 (8). The accessory piece of the copulatory organ has a broadening in its proximal part and then tapers at the end.

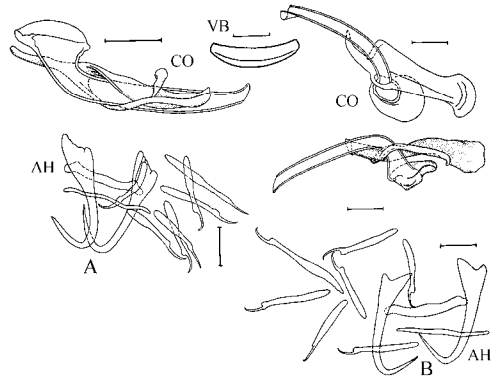
12 (13). The length of the anchors is less than 0.032 mm. The copulatory tube is **Г** shaped; the terminal projection of the accessory piece of the copulatory organ is short (twice as short as the proximal part).

D. magnicirrus Gussev, 1955 (Fig. 304)

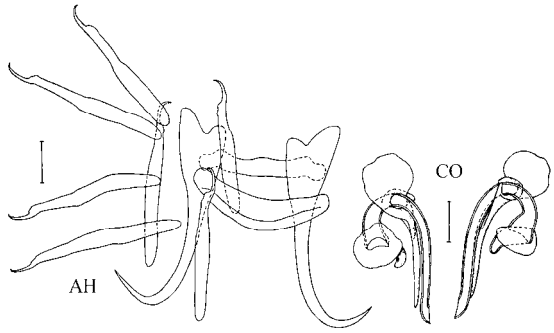
These are small worms; body can be up to 0.33 mm long and 0.10 mm wide. Length of marginal hooks is 0.018–0.031 mm. Length of anchors is 0.029–0.030 mm, main part 0.026–0.028 mm, inner root 0.004–0.006 mm, outer root 0.002–0.003 mm, point 0.011–0.012 mm. Size of dorsal bar is 0.002 x 0.021–0.026 mm, ventral bar 0.002–0.004 x 0.024–0.025 mm. Length of copulatory organ is about 0.060 mm, tube 0.043–0.050 mm.

13 (12). The length of the anchors is greater than 0.033 mm. The copulatory tube is sickle shaped; the terminal projection of the accessory piece of the copulatory organ is rather long (two times longer than the proximal part).

D. chenchihleui Gussev, 1962 (Fig. 305)



304



305

Fig. 304 – 305.
304 - *Dactylogyrus magnicirrus*: A – after Gussev, 1955b, B – after Gussev, 1962. **305 -** *Dactylogyrus chenchihleui* (after Gussev, 1962).

These are small worms; body can be up to 0.57 mm long and 0.12 mm wide. Length of marginal hooks is 0.023–0.045 mm. Length of anchors is 0.033–0.048 mm, main part 0.031–0.045 mm, inner root 0.006–0.008 mm, outer root 0.002–0.003 mm, point 0.010–0.013 mm. Size of dorsal bar is 0.003–0.004 x 0.025–0.029 mm, ventral bar 0.006–0.008 x 0.028–0.033 mm. Length of copulatory organ is 0.036–0.046 mm, copulatory tube 0.044–0.052 mm.

14 (7). The copulatory tube is rather thin and tapers to its end; vaginal armament is present.

15 (16). The initial part of the copulatory tube lacks fulcrate projections; the proximal part of the accessory piece is comb-like. The vaginal armament is a small funnel.
D. squaliobarbi Gussev, 1962 (Fig. 306)

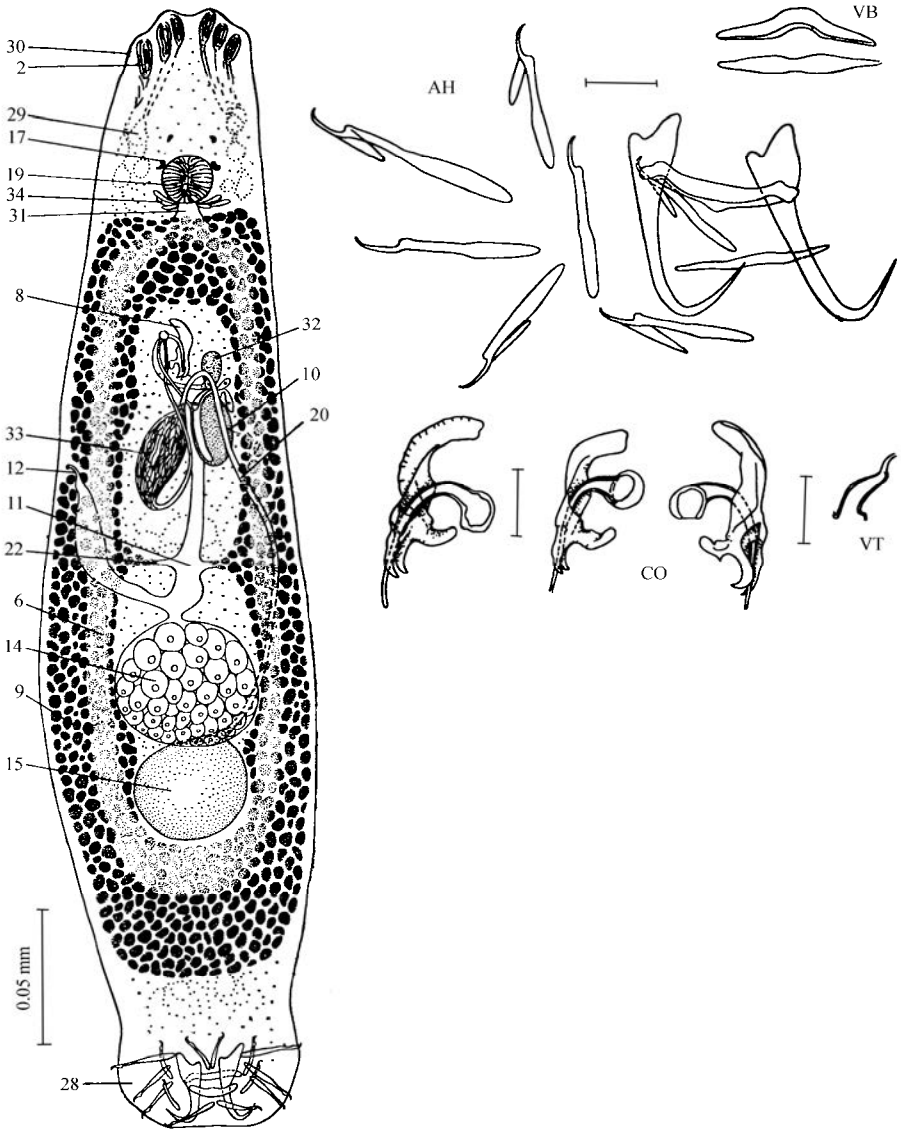
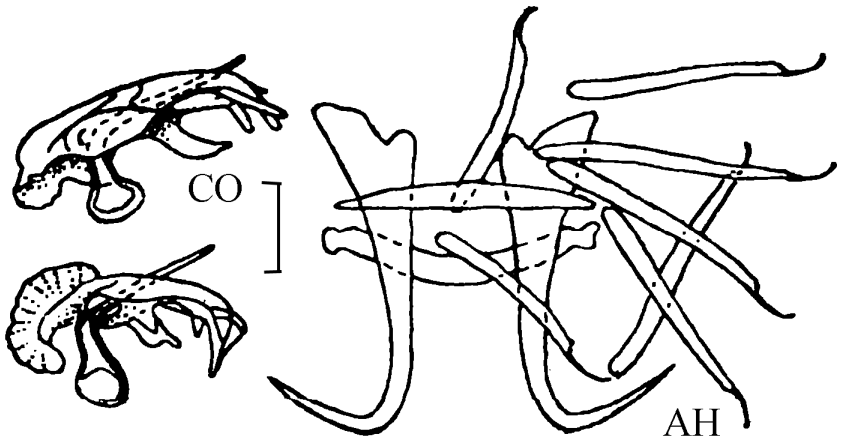


Fig. 306 - *Dactylogyrus squaliobarbi*.
Total view from ventral side (after Gussev, 1962), 34 – esophageal glands, the rest symbols are the same as on Fig. 1.

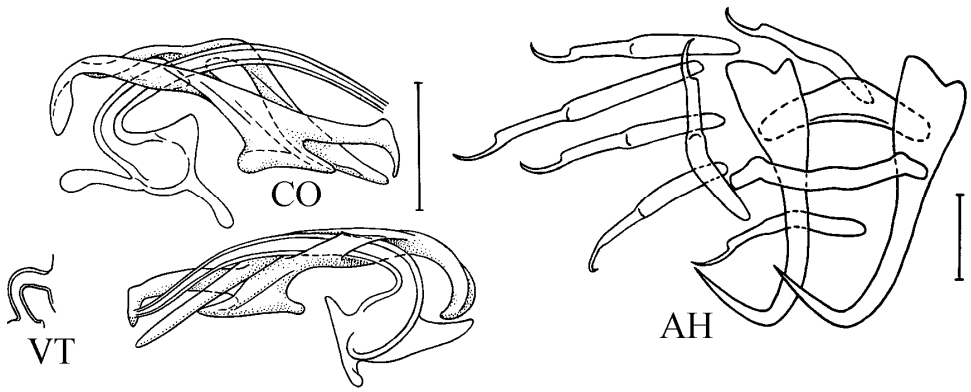
These are small worms; body can be up to 0.36 mm long and 0.09 mm wide. Length of marginal hooks is 0.018–0.033 mm. Total length of anchors is 0.026–0.032 mm, main part 0.023–0.028 mm, inner root about 0.006 mm, outer root about 0.003 mm, point 0.009–0.012 mm. Size of dorsal bar is 0.002–0.003 x 0.022–0.027 mm, ventral bar 0.002–0.007 x 0.018–0.024 mm. Length of copulatory tube is 0.021–0.027 mm, accessory piece 0.018–0.027 mm. Length of vaginal tube is 0.012 mm.

A subspecies *D. squaliobarbi tienmensis* Ling, 1965 was described in Chen et al. (1973). Body length is the same as that of the typical form. Length of marginal hooks is 0.022–0.036 mm. Length of anchors is 0.029–0.032 mm, inner root 0.004–0.007 mm, outer root 0.001–0.002 mm, point 0.009–0.011 mm. Size of dorsal bar is 0.002–0.003 x 0.025–0.030 mm, ventral bar 0.001–0.003 x 0.025–0.027 mm. Length of copulatory tube is 0.024–0.030 mm, accessory piece 0.025–0.030 mm. (Fig. 307). Initial part of copulatory tube of both forms lacks projections.

16 (15). The initial part of the copulatory tube has 2–3 fulcrate projections; the proximal part of the accessory piece is rachis-like; the vaginal armament is a short tube.
D. sungariensis Gussev, 1955 (Fig. 308)



307



308

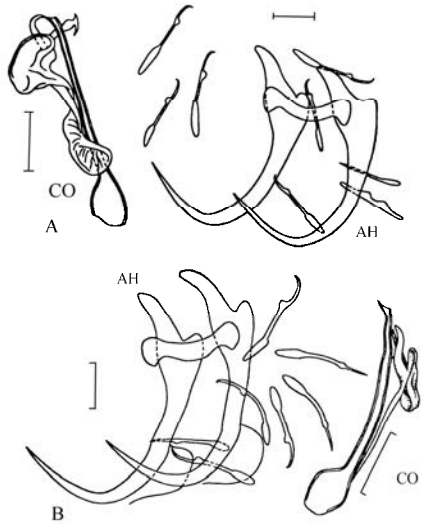
Fig. 307 – 308.
307 - *Dactylogyrus squaliobarbi tienmensis* (after Chen et al., 1973). **308 -** *Dactylogyrus sungariensis* (after Gussev, 1955b).

These are small worms; body can be up to 0.59 mm long and 0.10 mm wide. Length of marginal hooks is 0.019–0.042 mm. Total length of anchors is 0.030–0.042 mm, main part 0.026–0.037 mm, inner root 0.005–0.010 mm, outer root 0.003–0.005 mm, point 0.008–0.015 mm. Size of dorsal bar is 0.002–0.005 x 0.021–0.032 mm, ventral bar 0.004–0.008 x 0.020–0.034 mm. Length of copulatory tube is 0.035–0.048 mm, accessory piece 0.029–0.037 mm. Length of vaginal tube is about 0.007 mm.

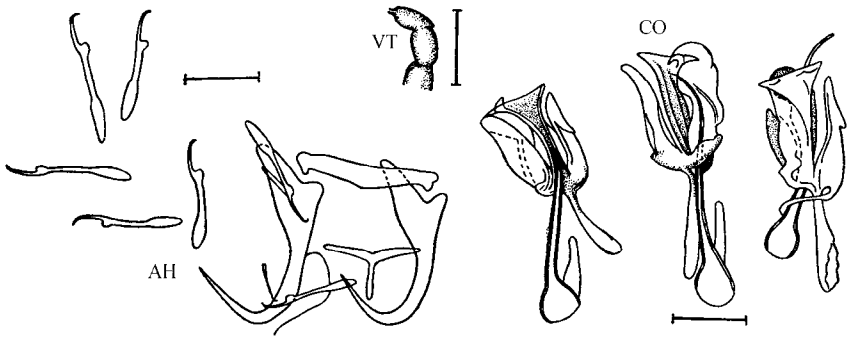
17 (6). The marginal hooks are rather short and thin and have a protruded heel. The anchors have a bent main part; the inner root is 5–6 times longer than the outer root and three times shorter than the main part. The copulatory tube is almost straight.

D. charbinensis Gussev, 1955 (Fig. 309)

These are small worms; body can be up to 0.33 mm long and up to 0.10 mm wide. Length of marginal hooks is 0.017–0.027 mm. Length of anchors is 0.045–0.053 mm, main part 0.040–0.048 mm, inner root 0.011–0.015 mm, outer root 0.002–0.003 mm, point 0.017–0.022 mm. Size of dorsal bar is 0.003–0.004 (0.006 at both ends) x 0.021–0.024 mm, ventral bar 0.002 x 0.016–0.018 mm. Length of copulatory organ that is equal to the length of its tube is 0.032–0.040 mm. Vaginal armament is absent.



309



310

Fig. 309 – 310.
309 - *Dactylogyrus charbinensis*: A – after Gussev, 1962, B – after Gussev, 1955b. **310 -** *Dactylogyrus panchinpeii* (after Gussev, 1962).

18 (5). The ventral bar is **T**-like.

19 (22). The posterior projection of the ventral bar is thin, less than half the length of the crossbar.

20 (21). The accessory piece of the copulatory organ looks like a “footed tumbler” or a tulip that is formed by three lobes and that sits on a rachis-like handle. The vaginal armament is a shining moniliform structure.

D. panchinpeii Gussev, 1962 (Fig. 310)

These are small worms; body can be up to 0.41 mm long and 0.10 mm wide. Length of marginal hooks is 0.015–0.027 mm. Length of anchors is 0.023–0.031 mm, main part 0.017–0.026 mm, inner root 0.007–0.012 mm, outer root 0.002–0.003 mm, point 0.011–0.015 mm. Size of dorsal bar is 0.002–0.005 x 0.019–0.024 mm, ventral bar 0.005–0.009 (with posterior projection) x 0.012–0.017 mm. Length of copulatory tube is 0.026–0.033 mm, accessory piece 0.025–0.031 mm. Length of vaginal armament is about 0.012 mm.

21 (20). The accessory piece of the copulatory organ is in the form of a crumpled long funnel; the vaginal armament is a bent tube with a discoid plate at its end.

D. chinensis Gussev, 1955 (Fig. 311)

These are small worms; body can be up to 0.47 mm long and 0.08 mm wide. Length of marginal hooks is 0.016–0.027 mm. Length of anchors is 0.024–0.029 mm, main part about 0.017–0.021 mm, inner root 0.010–0.013 mm, outer root 0.002–0.004 mm, point 0.013–0.016 mm. Size of dorsal bar is 0.002–0.005 x 0.022–0.027 mm, ventral bar 0.008 (with posterior projection) x 0.015–0.018 mm. Total length of copulatory organ is 0.029–0.037 mm. Length of bent vaginal tube is about 0.020 mm.

22 (19). The posterior projection of the ventral bar is linguiform. Its length is equal to or greater than the length of the crossbar.

D. chenyenhsinae Gussev, 1962 (Fig. 312)

These are small worms; length can be up to 0.32 mm, width 0.09 mm. Length of marginal hooks is 0.015–0.025 mm. Length of anchors is 0.029–0.033 mm, main part 0.021–0.025 mm, inner root 0.009–0.012 mm, outer root 0.001–0.003 mm, point 0.013–0.015 mm. Size of dorsal bar is 0.002–0.003 x 0.019–0.023 mm, ventral bar 0.011–0.015 (with the posterior projection) x 0.013–0.017 mm. Length of copulatory tube can be up to 0.036 mm, accessory piece 0.030–0.035 mm. Vaginal armament is a thin tube that is 0.015 mm long.

II. To date, thirteen species of *Dactylogyrus* that are found in China and Japan (excluding two species from cultured *Aristichthys nobilis*) are not found in the Amur region. All of them are from fishes that are common in the Amur River Basin or in its south tributaries.

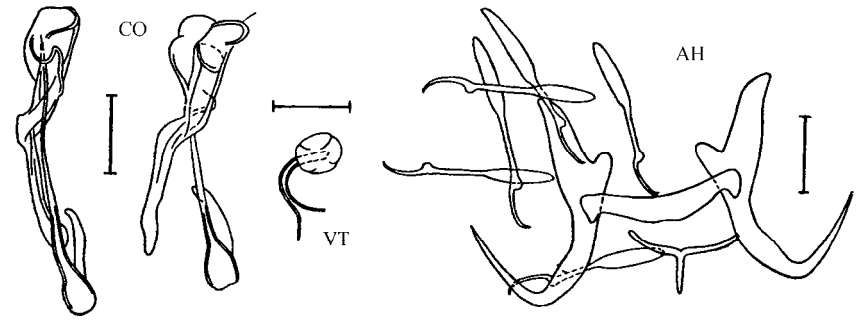
Species that lack the ventral bar of the haptor:

1) *D. nasali* Ling, 1973[63] (Fig. 313)

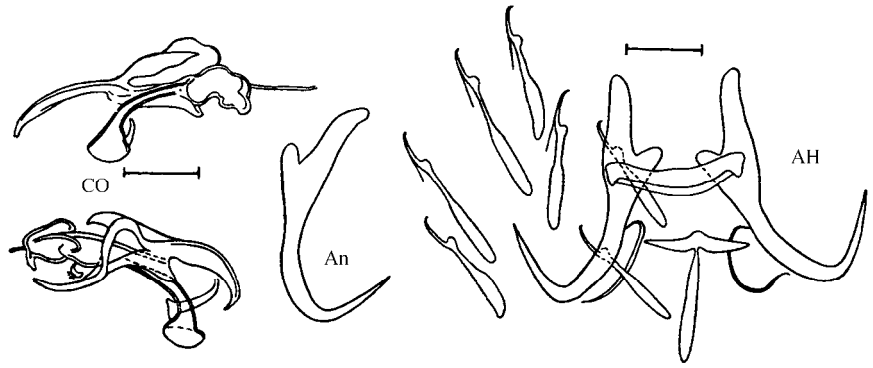
These are large or medium size worms; body can be up to 1.2 mm long and 0.3 mm wide. Length of marginal hooks is 0.017–0.022 mm. Length of anchors is 0.029–0.032 mm, main part 0.026–0.028 mm, inner root 0.010 mm, outer root 0.003–0.005 mm, point 0.018–0.021 mm. Size of dorsal bar is 0.003–0.006 x 0.032–0.035 mm. Length of copulatory organ is 0.032–0.040 mm. It differs from *D. yinwenyingae* in having marginal hooks of the larval type and by the presence of a massive dorsal bar.

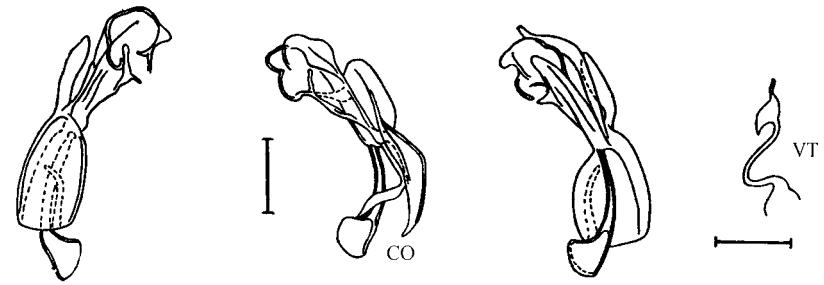
Found on gill filaments of Mylopharyngodon piceus; basin of the Yangtze River (China).

[63] This species can't be dated by 1965 as it is shown in Chen et al. (1973) because there is only the manuscript of Ling Mo-en in References. There was no such publication in 1965.

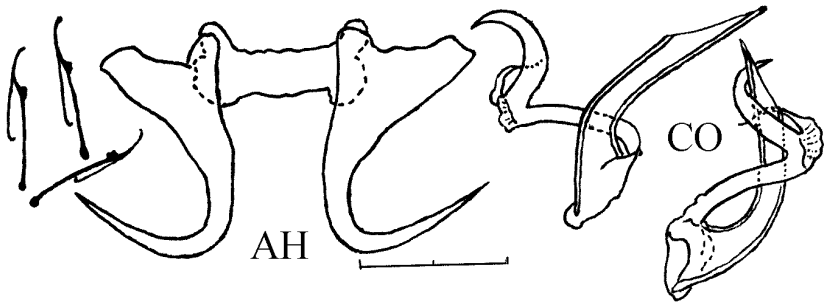


311





312



313

Fig. 311 – 313.
311 - *Dactylogyrus chinesis* (after Gussev, 1962). **312** - *Dactylogyrus chenyenhsinae* (after Gussev, 1962). **313** - *Dactylogyrus nasali* (after Chen et al., 1973).

2) ***D. biwaensis*** Ogawa et Egusa, 1982 (Fig. 314)

These are small or medium size worms; body can be up to 0.7 mm long and 0.15 mm wide. Length of marginal hooks is 0.021–0.027 mm. The anchors have an open point as in ***D. achmerovi***; dorso-apical length 0.042–0.051 mm, ventro-apical 0.041–0.048 mm, main part 0.038–0.045 mm, inner root 0.011–0.014 mm, outer root 0.004–0.006 mm. Size of dorsal bar is 0.004–0.005 x 0.026–0.032 mm. Length of copulatory organ is about 0.023 mm. The vaginal tube is poorly visible; its length is 0.030 mm.

Found on gill filaments of *Cyprinus carpio rubrofuscus*; Lake Biwa (Japan).

3) ***D. takahashii*** Ogawa et Egusa, 1982 (Fig. 315)

These are small or medium size worms; body can be up to 0.8 mm long and 0.13 mm wide. Length of marginal hooks is 0.020–0.029 mm. Length of anchors is 0.044–0.049 mm, main part 0.035–0.043 mm, inner root 0.014–0.018 mm, outer root 0.004–0.007 mm, point 0.015–0.017 mm. Size of dorsal bar is 0.002–0.005 x 0.026–0.032 mm. Length of copulatory organ is 0.020–0.027 mm. Vaginal armament is absent.

Found on gill filaments of *Cyprinus carpio rubrofuscus*; Lake Biwa (Japan).

This species is similar to ***D. minutus*** if we compare the size and shape of the anchors and copulatory organ.

Species has both dorsal and ventral bars; the ventral bar is shaped like a transverse stick without projections:

4) ***D. nobilis*** Long et Yu, 1958 (Fig. 316)

These are small or medium size worms; body can be up to 0.72 mm long and 0.17 mm wide. Length of marginal hooks is 0.031–0.049 mm. Length of anchors is 0.036–0.049 mm, main part 0.032–0.038 mm, inner root 0.017–0.019 mm, outer root 0.005–0.007 mm, point 0.015–0.016 mm. Size of dorsal bar, which is broadened in the middle, is 0.007–0.019 x 0.032–0.035 mm, ventral bar 0.002 x 0.030–0.032 mm. Length of copulatory organ is 0.035–0.038 mm. The vaginal armament is a round plate with a short tube.

Found on gill filaments of ***Aristichthys nobilis***; water bodies of China; widely distributed in fish farms of Russia, where big head has been introduced (infection is not high).

5) ***D. aristichthys*** Long et Yu, 1958 (Fig. 317)

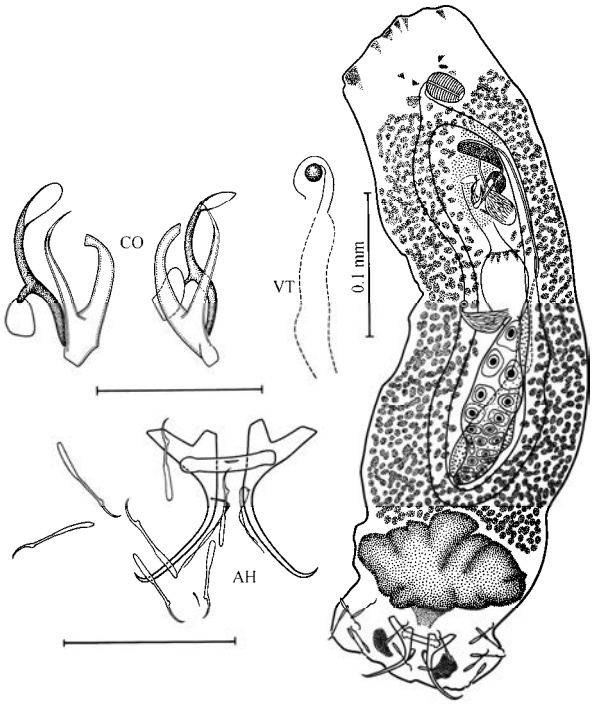
These are small or medium size worms; body can be up to 0.6 mm long and 0.14 mm wide. Length of marginal hooks is 0.024–0.039 mm. Length of anchors is 0.040–0.045 mm, main part 0.037–0.039 mm, inner root 0.010–0.013 mm, outer root 0.005–0.009 mm, point 0.007–0.009 mm. Size of dorsal bar is 0.004–0.007 x 0.027–0.031 mm, ventral bar 0.002–0.004 x 0.030–0.040 mm. Length of copulatory organ is 0.023–0.036 mm. Vaginal armament is absent.

Found on gill filaments of ***Aristichthys nobilis***; water bodies of China. Like the preceding species, this one is widely distributed in Russian fish farms; sometimes high infection occurs, but pathological changes of the gills have not been reported.

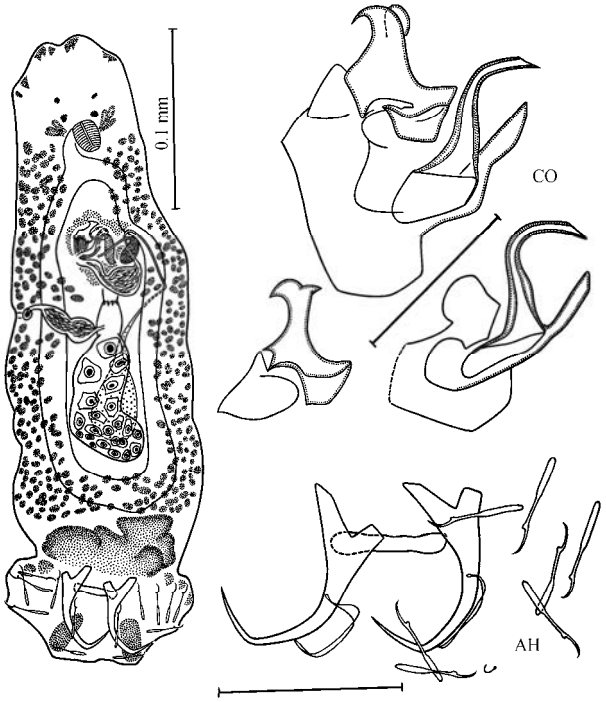
6) ***D. taihuensis*** Long et Lee, 1960 (Fig. 318)

These are small worms; body can be up to 0.4 mm long and 0.13 mm wide. Length of marginal hooks is 0.026–0.037 mm. The anchors have an open point and a broken end of it of the ***Dogielius*** type: dorso-apical length 0.045–0.048 mm, ventro-apical 0.050–0.055 mm, main part 0.043–0.045 mm, inner root 0.010–0.013 mm, outer root 0.008–0.009 mm, broken end of point 0.007–0.008 mm. Size of dorsal bar is 0.006–0.009 x 0.031–0.038 mm, ventral bar 0.004–0.005 x 0.035–0.040 mm. Length of copulatory organ is 0.020–0.027 mm. Vaginal armament is absent.

Found on gill filaments of ***Aristichthys nobilis***; water bodies of China.

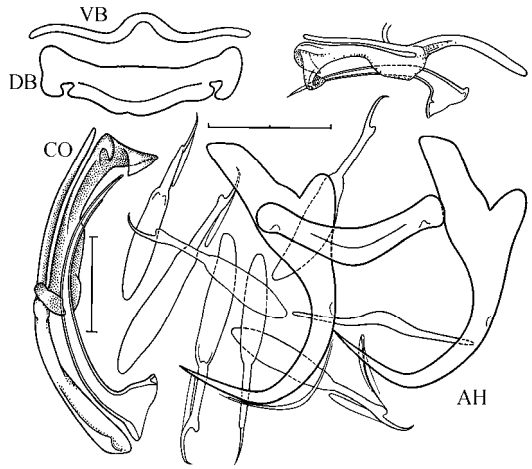


314

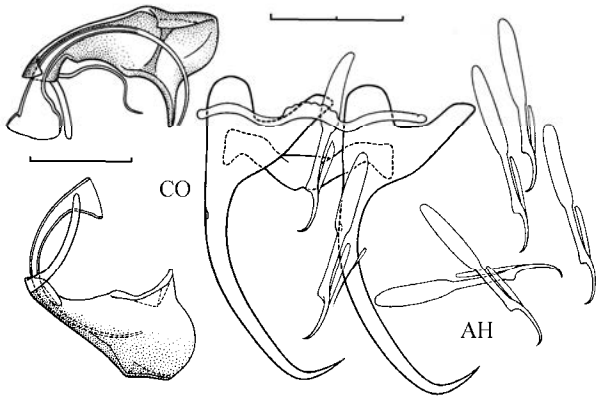


315

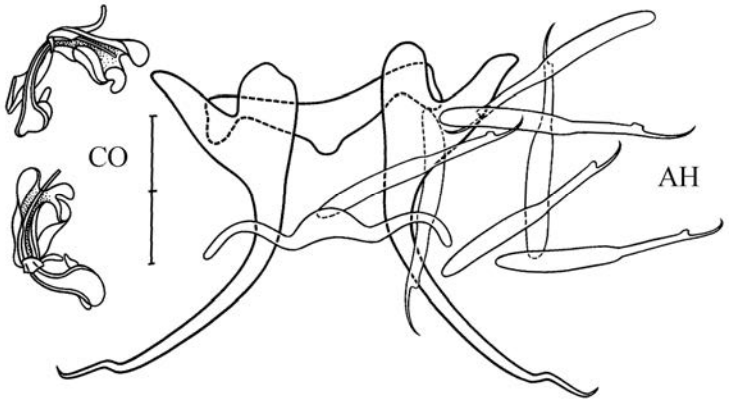
Fig. 314 – 315.
314 - *Dactylogyrus biwaensis*, ventral view (after Ogawa et Egusa, 1982). **315** - *Dactylogyrus takahashii*, ventral view (after Ogawa et Egusa, 1982).



316



317



318

Fig. 316 – 318.
316 - *Dactylogyrus nobilis*. **317** - *Dactylogyrus aristichthys*. **318** - *Dactylogyrus taihuensis* (after Chen et al., 1973).

7) *D. chini* Tchang, 1966 (Fig. 319)

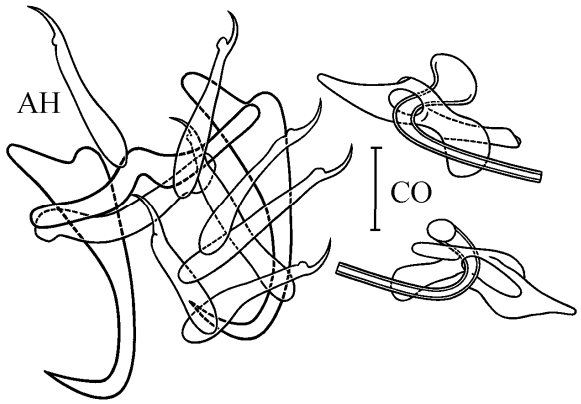
These are small or medium size worms; body can be up to 0.64 mm long and 0.14 mm wide. Length of marginal hooks is 0.020–0.036 mm. Length of anchors is 0.029–0.036 mm, main part 0.024 mm, inner root 0.008–0.012 mm, outer root 0.002 mm, point 0.007–0.012 mm. Size of dorsal bar is 0.003–0.004 x 0.024–0.027 mm, ventral bar 0.004–0.006 x 0.027–0.034 mm. Length of copulatory organ is 0.025–0.030 mm. Vaginal armament is absent.

Found on gill filaments of ***Hemiculter leucisculus***; Yangtze River (China).

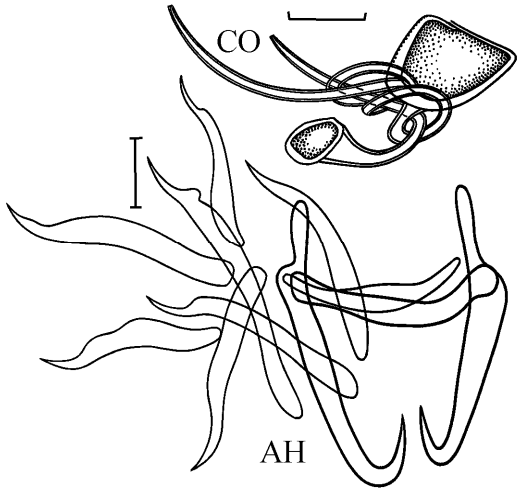
8) *D. helictocirrus* Long, 1964 (Fig. 320)

These are small worms; body can be up to 0.3 mm long and 0.065 mm wide. Length of marginal hooks (according to drawing) is 0.027–0.043 (in original description 0.023–0.026) mm. Length of anchors is about 0.040 mm, main part 0.030–0.035 (0.023) mm, inner root 0.009–0.011 (0.017) mm, outer root 0.001 mm, point 0.008 mm. Size of dorsal bar is 0.004 x 0.030 (0.023) mm, ventral bar 0.004 x 0.026 (0.002 x 0.018) mm. Total length of copulatory organ is 0.050 mm (description based on a single specimen).

Found on gill filaments of ***Culter alburnus***; Yangtze River Basin (Lake Tai Hu, China).



319



320

Fig- 319 – 320.
319 - *Dactylogyrus chini* (after Tchang, 1966). **320 -** *Dactylogyrus helictocirrus* (after Long, 1964).

Species whose the anchors have an ear-like projection on the shaft near where it switches to the point (o the "pterocleidus" type):

9) *D. tongtinensis* Long, 1964 (Fig. 321)

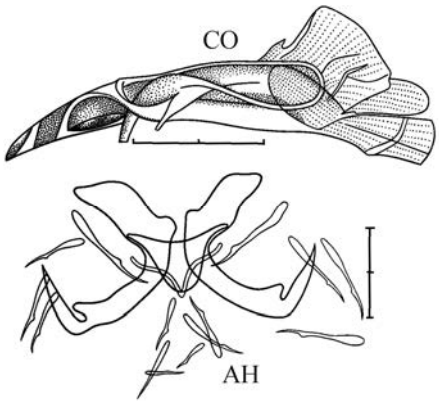
These are small or medium size worms; body can be up to 0.6 mm long and 0.09 mm wide. Length of marginal hooks is 0.012–0.027 mm. Length of anchors is 0.038–0.040 mm, main part 0.032–0.033 mm, inner root 0.017–0.020 mm, outer root 0.001–0.002 mm, point 0.017–0.020 mm. Size of dorsal bar is 0.013 x 0.02–0.050 (?) mm, **{**–shaped ventral bar 0.009 x 0.020–0.030 mm. Total length of copulatory organ is 0.040–0.073 mm.

Found on gill filaments of *Chanodichthys mongolicus*; Yangtze River Basin (Lake Tai Hu, China).

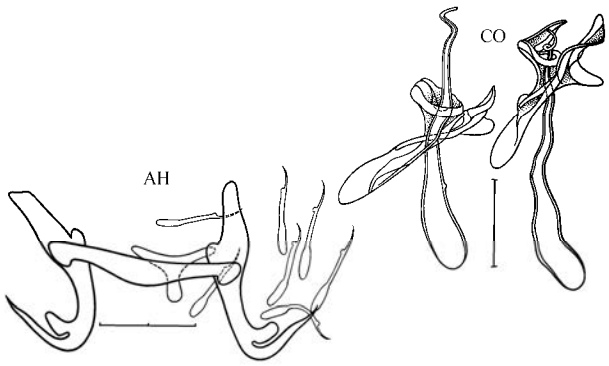
10) *D. parapterocleidus* Long, 1964 (Fig. 322)

These are small worms; body can be up to 0.4 mm long and 0.09 mm wide. Length of marginal hooks is 0.016–0.023 mm. Length of anchors is 0.034–0.043 mm, main part 0.026–0.030 mm, inner root 0.014–0.020 mm, outer root 0.001–0.003 mm, point 0.018–0.020 mm. Size of dorsal bar is 0.005–0.007 x 0.030–0.034 mm, **T**-shaped ventral bar 0.008–0.010 x 0.015–0.017 mm. Length of copulatory tube is 0.030–0.034 mm.

Found on gill filaments of *Culter alburnus*; Yangtze River Basin (Lake Tai Hu, China).



321



322

Fig. 321 – 322.
321 - *Dactylogyrus tongtinensis* (after Long, 1964). **322 -** *Dactylogyrus parapterocleidus* (after Chen et al., 1973).

Species whose the anchors lack projections on the shaft; the ventral bar is T (or +) shaped;

11) *D. ornithopodus* Tchang, 1966 (Fig. 323)

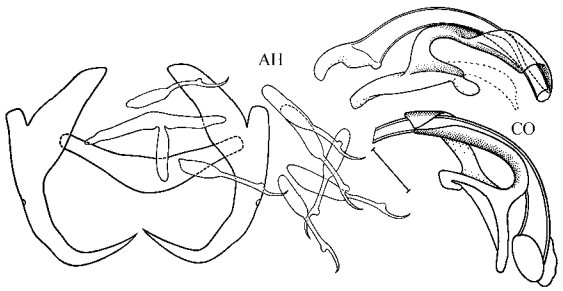
These are small or medium size worms; body can be up to 0.66 mm long and 0.12 mm wide. Length of marginal hooks is 0.019–0.029 mm. Length of anchors is 0.033–0.039 mm, main part 0.025–0.028 mm, inner root 0.014–0.016 mm, outer root 0.002–0.005 mm, point 0.010–0.012 mm. Size of dorsal bar is 0.004–0.006 x 0.026–0.034 mm, ventral bar 0.010–0.012 x 0.019–0.025 mm. Length of copulatory organ is 0.043–0.050 mm. Vaginal armament is absent.

Found on gill filaments of *Hemiculter leucisculus*; Yangtze River (China).

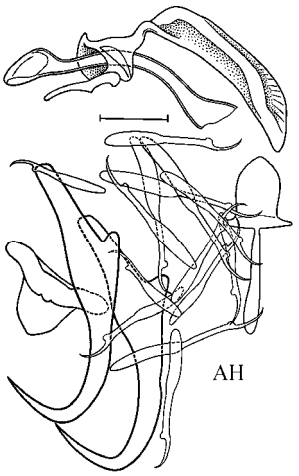
12) *D. hemiculteris* Tchang, 1966 (Fig. 324)

These are small worms; body can be up to 0.4 mm long and 0.07 mm wide. Length of marginal hooks is 0.015–0.028 mm. Length of anchors is 0.033–0.041 mm, main part 0.023–0.027 mm, inner root 0.012–0.015 mm, outer root 0.002 mm, point 0.010–0.011 mm. Size of dorsal bar is 0.004 (with posterior projection up to 0.010) x 0.014–0.018 mm, ventral bar 0.026 x 0.011 (in original description 0.033–0.038 x 0.010–0.012) mm. Total length of copulatory organ is 0.043–0.052 mm, copulatory tube 0.033–0.038 mm.

Found on gill filaments of *Hemiculter leucisculus*; Yangtze River (China).



323



324

Fig. 323 – 324.
323 - *Dactylogyrus ornithopodus* (lower copulatory organ – after Chen et al., 1973). **324 -** *Dactylogyrus hemiculteris*.

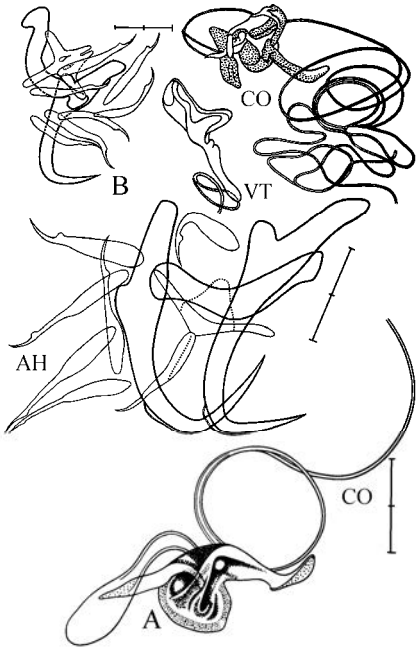
13) *D. pseudoflagellicirrus* Long, 1964 (Fig. 325)

These are small worms; body can be up to 0.55 mm long and 0.18 mm wide. Length of marginal hooks is 0.020–0.030 mm. Length of anchors is 0.051–0.055 mm, main part 0.038–0.040 mm, inner root 0.019 mm, outer root 0.003–0.004 mm, point 0.018–0.019 mm. Size of dorsal bar is 0.006–0.008 x 0.035–0.040 mm, ventral bar 0.026–0.029 x 0.028–0.033 mm. Total length of copulatory organ is about 0.10 mm; the filiform tube is twisted and greater than 0.30 mm long. The vaginal tube also is filiform and forms several loops; length about 0.30 mm.

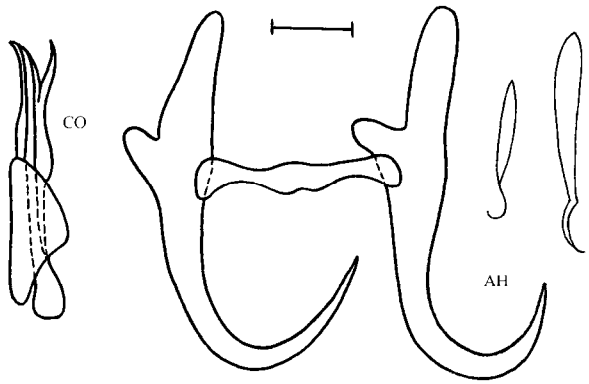
Found on gill filaments of *Chanodichthys erythropterus*; Yangtze River (Lake Tai Hu, China).

III. *D. acanthorhodei* Akhmerov, 1952 is to be considered a species inquirenda.

D. acanthorhodei Akhmerov, 1952 (Fig. 326)

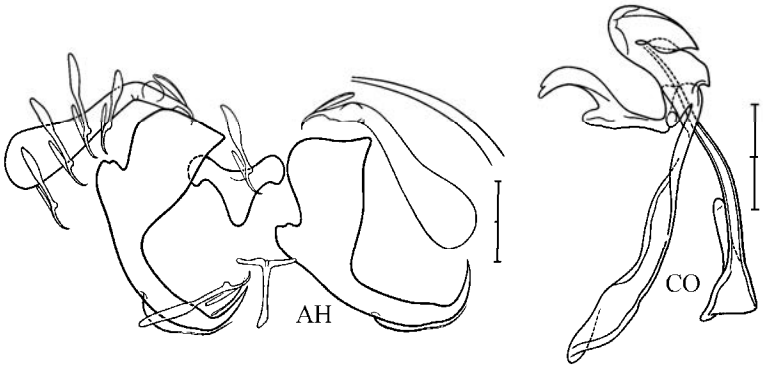


325

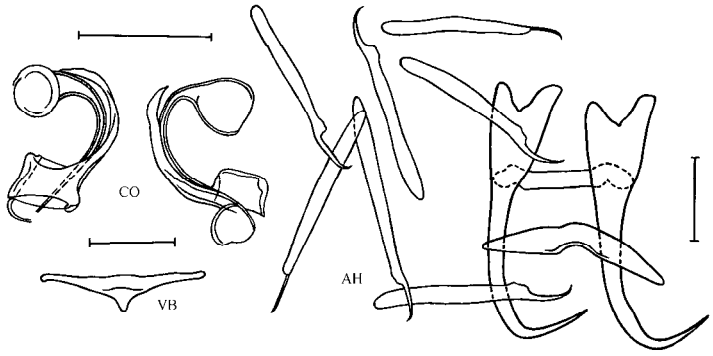


326

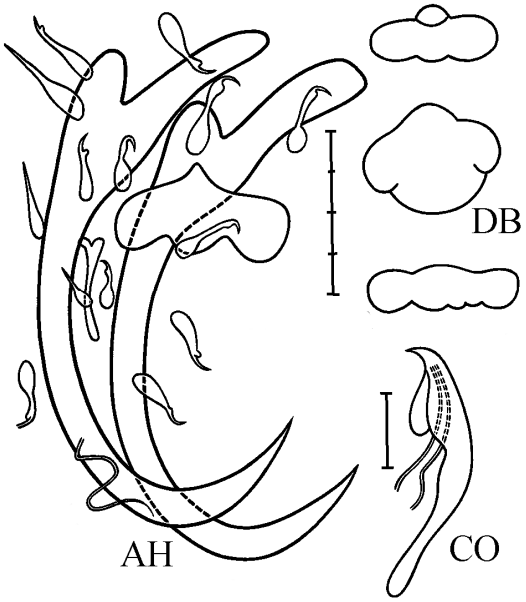
Fig. 325 – 326.
325 - *Dactylogyrus pseudoflagellicirrus*: A – after Long, 1964, B – after Tchang, 1966.
326 - *Dactylogyrus acanthorhodei* (after Akhmerov, 1952).



327



328



329

Fig. 327 – 329.
327 - *Dactylogyrus jukhimenkoi*. **328 -** *Dactylogyrus niedashui* (after Gussev, 1967).
329 - *Dactylogyrus wuhanensis* (after Tchang et Ji, 1980).

Length of marginal hooks is 0.017–0.024 mm. Length of anchors is 0.042 mm, main part 0.028 mm, inner root 0.015 mm, outer root 0.003–0.004 mm, point 0.015–0.017 mm. Size of dorsal bar is 0.004 x 0.021 mm. Length of copulatory organ is 0.030 mm.

Found on gills of *Acanthorhodeus asmussi*; Amur River (Russia).

A rather schematic drawing makes identification of this species very difficult. No one has found it since on *Acanthorhodeus*. Perhaps it is a species that infects *A. asmussi* accidentally. It also could be a different species, such as *D. fragilis* from *Chanodichthys mongolicus* (the ventral bar may have been overlooked).

IV. *D. jukhimenkoi* Gussev, 1985 (Fig. 327)

This is a small worm; body length is about 0.5 mm, width 0.12 mm. Length of marginal hooks of one pair (the third one ?) is 0.055 mm, width of the handle end is about 0.012 mm, other hooks 0.020–0.030 mm. The anchors are of the "sphyrna" type but are slightly changed; their roots are shorter. Total anchor length is 0.055 mm, main part 0.043 mm, inner root 0.019 mm (the same width at its end), outer root 0.003 (width at base 0.006) mm, point 0.016 mm. Size of the **T**-shaped dorsal bar is 0.015 x 0.024 mm, **T**-shaped ventral bar 0.017 x 0.015 mm. Total length of copulatory organ is about 0.070 mm; the tube is slightly shorter. The vaginal armament is a thin bent tube about 0.034 mm long.

Found on gill filaments of *Parabramis pekinensis*; Lake Khanka (Russia).

V. *D. niedashui* Gussev, 1967 (Fig. 328)

These are minute worms; body can be up to 0.15 mm long and 0.04 mm wide. Marginal hooks have a poorly delimited handle and the heel of the point is smooth. Length of marginal hooks in most cases is 0.021–0.028 (in one case, 0.018 mm for the first pair and 0.035 mm for the VI pair) mm. Total length of anchors is 0.029–0.033 mm, main part 0.026–0.029 mm, equal roots 0.004–0.006 mm, point 0.008–0.011 mm. Size of dorsal bar is 0.002 x 0.016–0.020 mm, ribbon-shaped ventral bar 0.004–0.005 x 0.022–0.026 mm (a ribbon-shaped bar also is found in *D. primarius, D. juveniformis*, and several other species from *Squaliobarbus*). Total length of copulatory organ is about 0.013 mm, sickle-shaped copulatory tube with a bubble-shaped initial part about 0.018 mm. Vaginal armament is absent.

Found on gill filaments of *Aphyocypris chinensis*, Liao He River (China). Perhaps it also will be found in the Amur River on a migrating host.

VI. Several other species were described in China and in the future they might possibly be found in the Amur River.

1) *D. wuhanensis* Tchang et Ji, 1980 (Fig. 329)

Body length is 0.5–1.0 mm, width 0.08–0.18 mm. Length of marginal hooks is 0.016–0.025 mm. Length of anchors is 0.114–0.115 mm, main part 0.10–0.13 mm, inner root 0.032–0.052 mm, outer root 0.007–0.012 mm, point 0.028–0.046. Size of dorsal bar is 0.012–0.022 x 0.026–0.042 mm, ventral bar 0.030–0.033 x 0.005–0.006 mm. Length of copulatory organ is 0.037–0.042 mm.

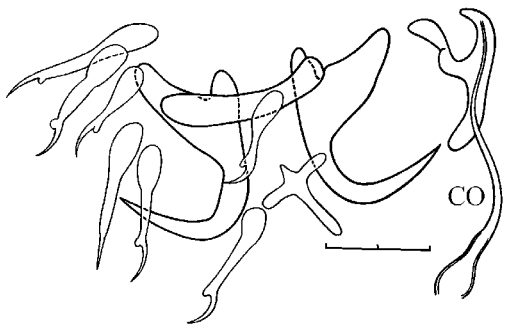
Found on gill filaments of *Plagiognathops microlepis*; Yangtze River Basin.

2) *D. ancistroides* Tchang et Ji, 1980 (Fig. 330)

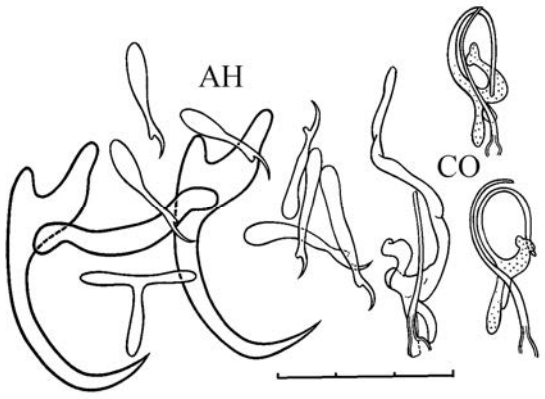
Body length is 0.74–0.82 mm, width 0.15–0.17 mm. Length of marginal hooks is 0.018–0.025 mm. Length of anchors is 0.030–0.033 mm, main part 0.020–0.021 mm, inner root 0.015–0.017 mm, outer root 0.005–0.007 mm, point 0.016–0.017 mm. Size of dorsal bar is 0.003–0.004 x 0.029–0.033, **T**-shaped ventral bar 0.013–0.017 x 0.013–0.017 mm. Length of copulatory organ is 0.055–0.068 mm.

Found on gill filaments of *Plagiognathops microlepis*; Yangtze River.

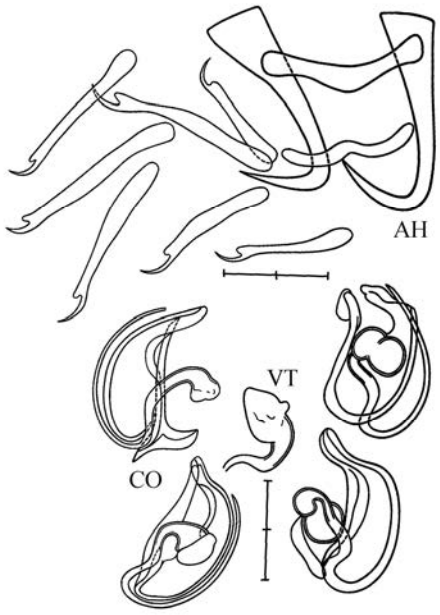
3) *D. auriformis* Tchang et Ji, 1980 (Fig. 331)



330



331



332

Fig. 330 – 332.
330 - *Dactylogyrus ancistroides* (after Tchang et Ji, 1980). **331 -** *Dactylogyrus auriformis* (after Tchang et Ji, 1980). **332 -** *Dactylogyrus petaloideus* (after Tchang et Ji, 1980).

These are small worms; body can be up to 0.50 mm long and 0.11 mm wide. Length of marginal hooks is 0.018–0.027 mm. Length of anchors is 0.037–0.039 mm, main part 0.029–0.031 mm, inner root 0.010–0.014 mm, outer root 0.005 mm, point 0.010–0.014 mm. Size of dorsal bar is 0.002–0.004 x 0.027–0.032 mm, **T**-shaped ventral bar 0.011–0.012 x 0.016–0.019 mm. Length of copulatory organ is 0.033–0.038 mm.

Found on gill filaments of *Plagiognathops microlepis*; Yangtze River Basin.

4) *D. petaloideus* Tchang et Ji, 1980 (Fig. 332)

Body length can be up to 0.70 mm long and 0.12 mm wide. Length of marginal hooks is 0.022–0.042 mm. Length of anchors without roots *(*of the "juveniformis" type) is 0.033–0.037 mm, point 0.011–0.012 mm. Size of dorsal bar is 0.002–0.003 x 0.024–0.027 mm, ventral bar 0.002–0.003 x 0.022–0.024 mm. Total length of copulatory organ with bent tube is 0.028–0.033 mm.

Found on gill filaments of *Plagiognathops microlepis*; Yangtze River Basin.

5) *D. lophogonus* Tchang et Ji, 1980 (Fig. 333)

These are small worms; body can be up to 0.41 mm long and 0.086 mm wide. Length of marginal hooks is 0.016–0.024 mm. Length of anchors is 0.016–0.022 mm, main part 0.013–0.019 mm, inner root 0.007–0.010 mm, outer root 0.005–0.007 mm, point about 0.008 mm. Size of dorsal bar is 0.002–0.003 x 0.018–0.022 mm, **V**-shaped ventral bar 0.026 x 0.024 mm (of the "bicornis" type). The copulatory organ is large; total length 0.070–0.080 mm.

Found on gill filaments of *Rhodeus* sp.; Yangtze River Basin.

6) *D. guizhouensis* Long et Tao, 1982 (Fig. 334 A)

Syn.: *D. microtheloides* Zhang, 1983

Body length is 0.48–0.80 mm, width 0.08–0.014 mm. Length of marginal hooks is 0.024–0.039 mm. Length of anchors ("wunderi" type) is 0.048–0.099 mm, main part 0.069–0.081 mm, inner root 0.030–0.033 mm, outer root 0.003 mm, point 0.024–0.039 mm. Size of dorsal bar is 0.006–0.010 x 0.030–0.036 mm. The copulatory organ is of the "cryptomeres" type but slightly changed; length of the **S**-shaped copulatory tube is 0.045–0.051 mm. The ventral bar was omitted from the first description.

Found on gill filaments of *Saurogobio dabryi*, Yangtze River Basin.

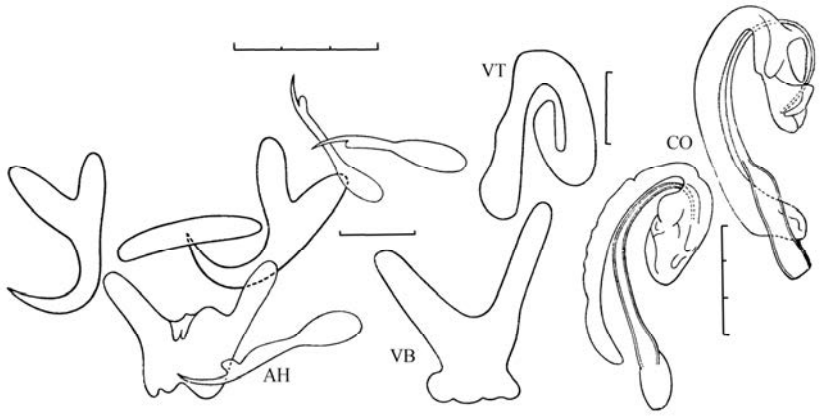
7) *D. guangxiensis* Long et Tao, 1982 (Fig. 334 B)

Body length is 0.48–0.75 mm, width 0.13–0.20 mm. Length of marginal hooks is 0.030–0.051 mm. Length of anchors is 0.036–0.040 ("wunderi" type), main part 0.030–0.033 mm, inner root 0.015 mm, outer root 0.006 mm, point 0.015 mm. Size of dorsal bar is 0.003–0.006 x 0.027–0.042 mm. The copulatory organ is of the "cryptomeres" type; length of the tube with a projection at the initial part is 0.054–0.057 mm. The ventral bar was omitted from the first description.

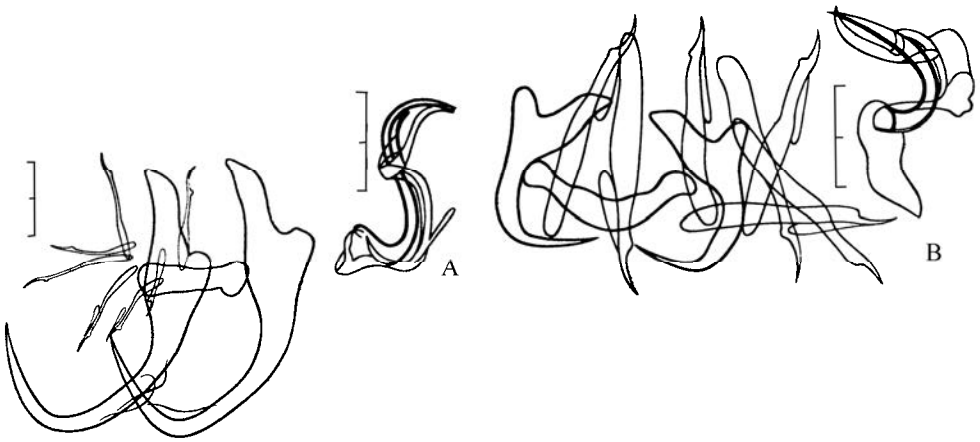
Found on gill filaments of *Saurogobio dabryi*, Yangtze River Basin.

Genus *Pellucidhaptor* Price et Mizelle, 1964

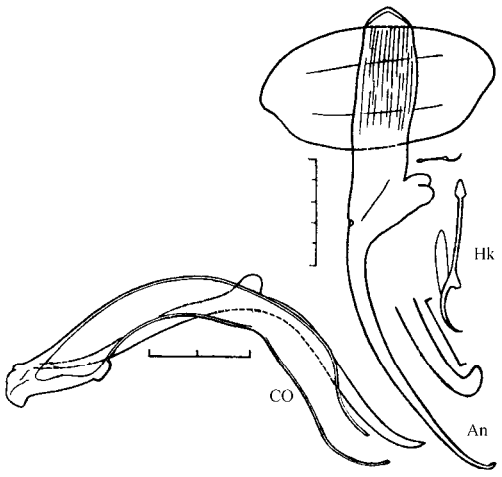
These Dactylogyridae have an elongate body and two pairs of eyes. The haptor is separated from the body by a distinct peduncle and has seven pairs of marginal hooks, one pair of needle-shaped structures, one pair of anchors, and only one rather rough dorsal bar. The anchors in most species have a short inner and a long outer root and the point is open or sometimes recurvate; in the latter case its end is bent outside. The intestine has two caeca that unite posteriorly and lack projections. The vas deferens loops around the left intestinal caecum. The ovary lies equatorially and the vaginal duct is unpaired and dextroventral; the vitellaria may extend to the haptor. Other features are the same as in all Dactylogyridae.



333



334



335

Fig. 333 – 335.
333 - *Dactylogyrus lophogonus* (after Tchang et Ji, 1980). **334 -** A - *Dactylogyrus guizhouensis*, B – *D. guangxiensis* (after Long et Tao, 1982). **335 -** *Pellucidhaptor catostomi* (from Dechtiar slide, Lake Huron).

Found on the skin and nasal cavities and sometimes gills of Catostomidae (rarely on Cyprinidae).

The type species is *P. pellucidhaptor* Price et Mizelle, 1964 from the gills of the cyprinid *Richardsonius egregius* (Girard) from California, USA. Nineteen species have been described from the Nearctic and four from the Palaearctic. The anatomical structures of the Palaearctic species have not been studied and those from America have been studied rather poorly. It is possible to find *P. catostomi* Dechtiar, 1969 (Fig. 335) on *Catostomus catostomus* from the northeastern part of Russia.

Key to species of the genus *Pellucidhaptor*

1 (2). The anchors have recurved points and equal roots. The copulatory tube is very thin and tapers to its end.
P. merus (Zaika, 1961) (Fig. 336)
Syn.: *Dactylogyrus merus* Zaika, 1961

These are small worms; body can be up to 0.4 mm long and 0.09 mm wide. Length of marginal hooks is 0.015–0.020 mm. Length of anchors (ventro-apical) is 0.066–0.086 mm, main part 0.046–0.071 mm, inner root 0.012–0.018 mm, outer root 0.013–0.019 mm, point 0.019–0.026 mm. Size of dorsal bar is 0.007–0.013 x 0.042–0.062 mm. Total length of copulatory organ is 0.037–0.056 mm, diameter of copulatory tube in the middle about 0.0025 mm. Vaginal armament is absent.

Found in nasal and mouth cavities and rarely on skin and gills of *Phoxinus phoxinus* and *P. czekanowskii*; found in different regions of the Palaearctic from the Kolyma River and Lake Baikal (Russia) up to the Oder and Elbe Rivers, as well as in the Amur region (personal communication of Yukhimenko).

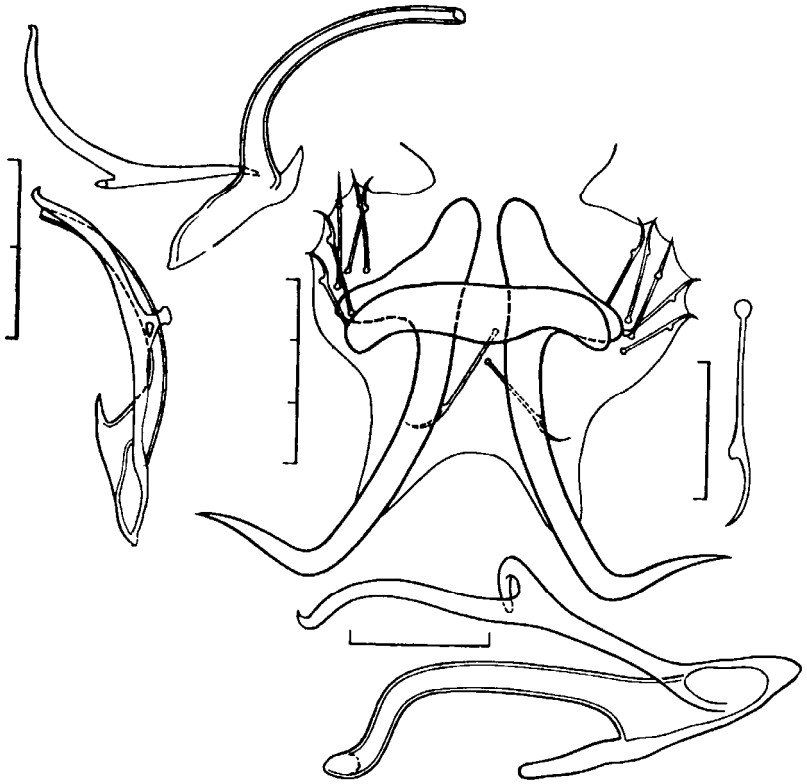


Fig. 336 - *Pellucidhaptor merus* (after Gussev, 1962).

2 (1). The anchors have an open point and a very small inner root and a very large outer root.

3 (6). The copulatory tube is wide and widens to its end.

4 (5). The length of the marginal hooks is less than 0.020 mm; anchor length is less than 0.120; dorsal bar is 0.080 mm. The copulatory organ is less than 0.070 mm long.
P. rogersi Gussev et Lukjanceva, 1971 (Fig. 337)

These are small or medium size worms; body can be up to 0.6 mm long and 0.01 mm wide. Length of marginal hooks is 0.016–0.017 mm. Length of anchors (ventro-apical) is 0.110–0.117 mm, main part 0.070–0.077 mm, inner root 0.001–0.002 mm, outer root 0.040–0.043 mm. Size of dorsal bar is 0.020–0.028 x 0.071–0.078 mm. Length of copulatory organ is 0.057–0.064 mm, diameter of copulatory tube in the middle greater than 0.003 mm. Vaginal armament is absent.

Found on skin of *Leuciscus leuciscus baikalensis* and *Phoxinus phoxinus*; Ob' River and the Yenisey Basin (Russia).

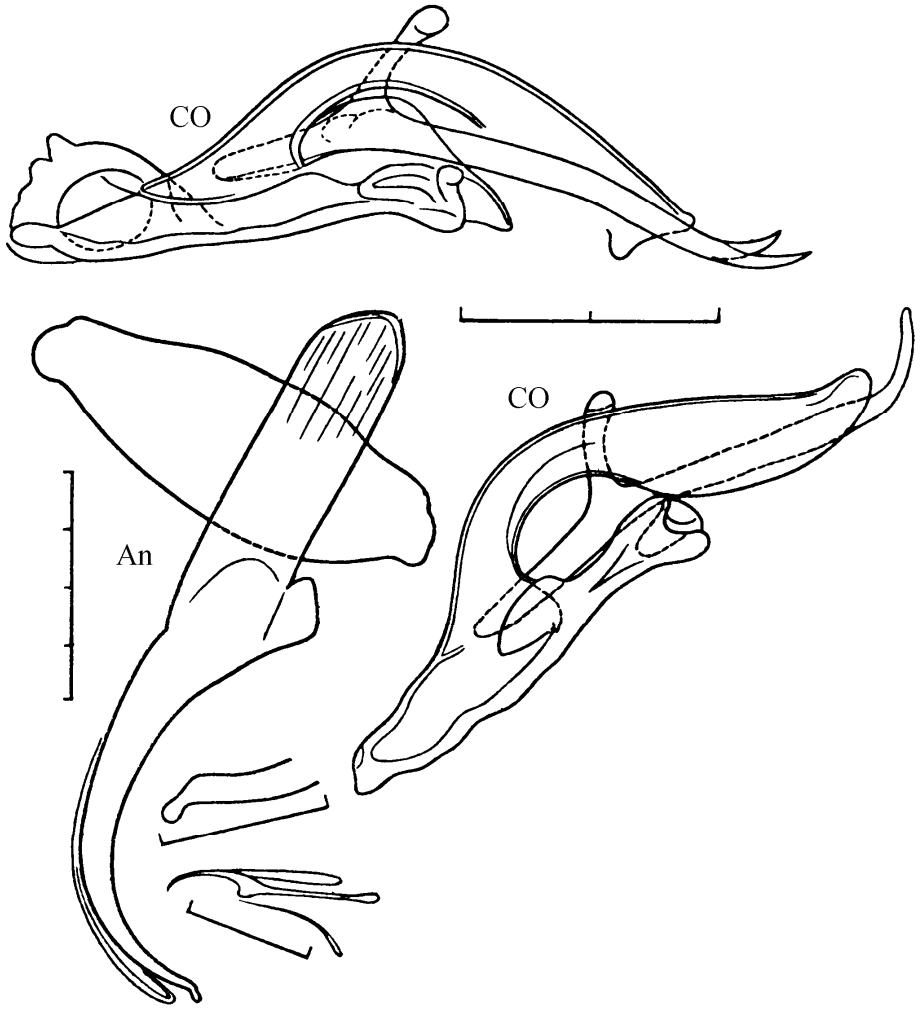


Fig. 337 - *Pellucidhaptor rogersi* (after Gussev et Lukjanceva, 1971).

5 (4). The length of the marginal hooks is 0.022 mm; anchors are longer than 0.31 mm; dorsal bar is 0.16 mm. The copulatory organ is greater than 0.10 mm long.
P. pricei Gussev et Strijak, 1972 (Fig. 338)

These are large worms; body can be up to 1.0 mm long. Length of marginal hooks is 0.022 mm. Length of anchors is 0.31 mm, main part 0.17 mm, inner root 0.008 mm, outer root 0.14 mm. Size of dorsal bar is 0.080 x 0.160 mm. Length of copulatory organ is 0.12 mm, diameter of copulatory tube about 0.006 mm. Vaginal armament is absent.

Found in nasal cavities of *Abramis brama*; Volga River (Russia); Lake Nevezhis (Lithuania). Found very rarely.

6 (3). The copulatory tube is wide but does not widen to its end.
P. fidus Pugachev, 1989 (Fig. 339)

Length of marginal hooks is 0.20–0.022 mm. Length of anchors is 0.117–0.135 mm, main part 0.071–0.074 mm, inner root 0.009–0.011 mm, outer root 0.047–0.061 mm. Size of dorsal bar is 0.035–0.059 x 0.087–0.102 mm. Length of copulatory organ is 0.065–0.073 mm, length of copulatory tube 0.057–0.063 mm, diameter about 0.004 mm. Vaginal armament is absent.

Found on gills of *Phoxinus percnurus*; Anadyr' River (Chukotka, Russia).

Genus *Dogielius* Bychowsky, 1936

The haptor of these Dactylogyridae has the same structure as in the genus *Dactylogyrus*. Only one dorsal bar is present, but it is displaced from anchors to the ventral side; the anchors are unfolded and its unbend points direct towards each other (they attach to gill filaments by embracing them). The end of the point may have a typical sharp bend (these are of the "dogielius" type) or lack the sharp bend (these are of the "falkatus" type). Four eyes are present. In most cases the genital opening lies under the left intestinal caecum (but in some cases it may be under the right?)[64]; it is offset from the middle of the body. The testis lies at the side of the ovarium. The vaginal duct is unpaired and opens near the body ridge under the right (or under the left) [65] intestinal caecum.

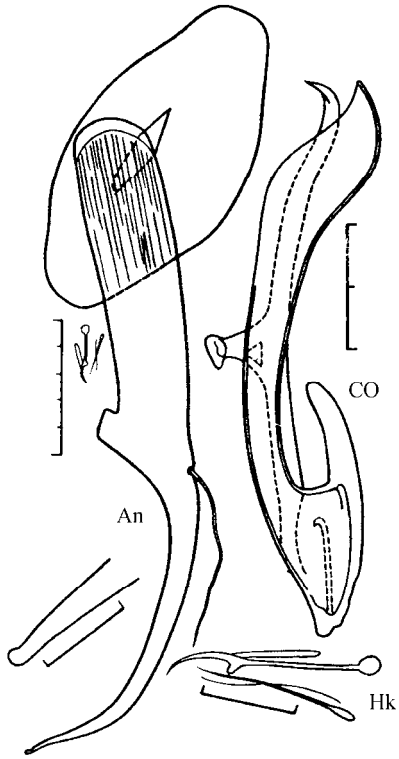
These are gill parasites of Cyprinids.

The type species is *D. forceps* Bychowsky, 1936. There are 27 species in the genus: 17 have been described in Africa; 4 in China, and 1 in India. Five species have been found in the Palaearctic region.

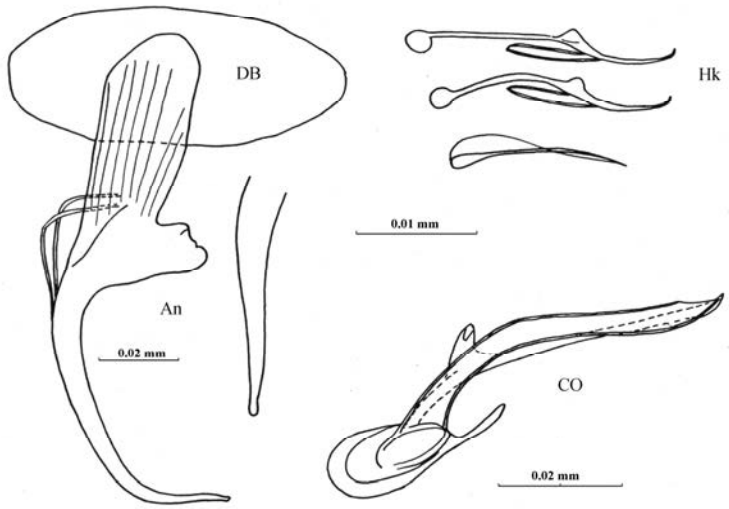
At one time the difference between the genera *Dactylogyrus* and *Dogielius* seemed to be very distinct. However some species of *Dogielius* from Africa and India have no typical sharp bend of anchor's point, therewith *Dactylogyrus taihuensis* Long et Lee 1960 from China has a typical sharp bend of the anchor's point and ventral and dorsal bars. These data made differences between these two genera not so distinct. Details of the anatomical structures are poorly known. For example, nothing is known about the position of the vas deferens of the *Dogielius* species. The position of testis at the side of ovarium (this feature has been used in diagnosis of *Dogielius*) and the attachment to gill filaments by embracing them can be found in several species of *Dactylogyrus* and in some other genera and are to be considered as convergent features, as is the "pterocleidus" anchors that are found in different Monogenoidea. Further and more detailed morphological studies are necessary to prove the validity of the genus *Dogielius*.

Key to species of the genus *Dogielius*
1 (8). The anchors have a sharp bent end of the point.

[64] These features need to be revised.
[65] These features need to be revised.

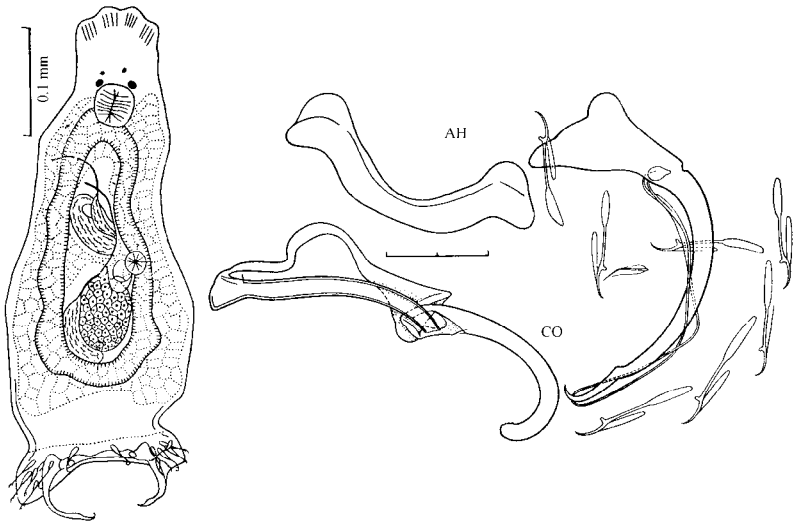


338

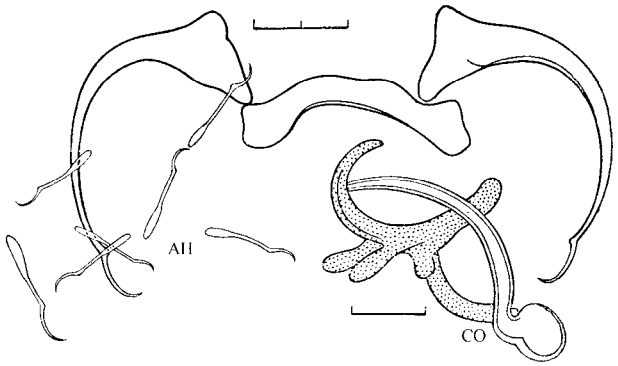


339

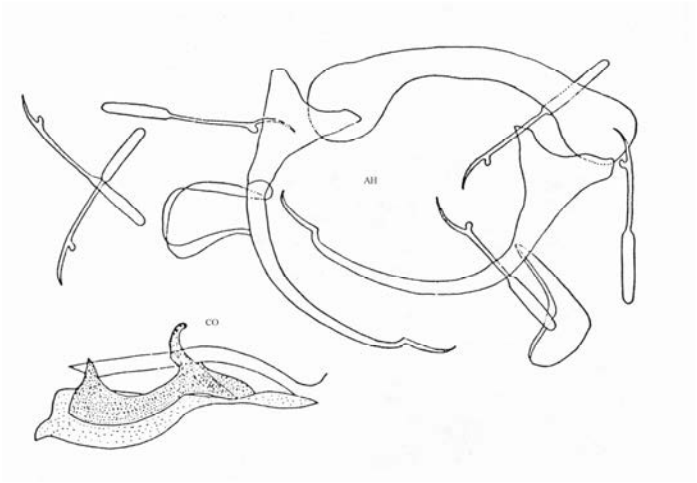
Fig. 338 – 339.
338 - *Pellucidhaptor pricei* (after Gussev et Strijak, 1972). **339 -** *Pellucidhaptor fidus* (after Pugachev, 1989).



340



341



342

Fig. 340 – 342.
340 - *Dogielius forceps*. **341** - *Dogielius planus* (after Bychowsky, 1957b). **342** - *Dogielius mokhayeri* (after Jalali et Molnar, 1990).

2 (3). The accessory piece of the copulatory organ lacks supplementary projections.
D. forceps Bychowsky, 1936 (Fig. 340)

These are small worms; body can be up to 0.4 mm long and up to 0.15 mm wide. Length of marginal hooks is 0.021–0.027 mm. Length of anchors (ventro-apical) is about 0.060 mm, main part 0.052 mm, inner root 0.011–0.012 mm. Size of dorsal bar is 0.005–0.008 x 0.059–0.064 mm. Total length of copulatory organ can be up to 0.064 mm. Vaginal armament is absent.

Found on gill filaments of *Schizothorax intermedius*, *S. pseudaksaensis*, and *S. p. issykkuli*; water bodies of Central Asia and Kazakhstan.

3 (2). The accessory piece of the copulatory organ has supplementary projections.

4 (5). The length of the copulatory organ is greater than 0.040 mm.
D. planus Bychowsky, 1957 (Fig. 341)

These are minute worms; body can be up to 0.3 mm long and 0.11 mm wide. Length of marginal hooks is 0.019–0.025 mm. Ventro-apical length of anchors is 0.055–0.065 mm, main part 0.050–0.052 mm, inner root about 0.009 mm, outer root 0.001–0.003 mm, sharp bent end of point 0.011–0.013 mm. Size of dorsal bar is 0.005–0.008 x 0.045–0.049 mm. Length of copulatory organ is 0.040-0.046 mm. Vaginal armament is absent.

Found on gill filaments of *Schizothorax intermedius*; Amudar'ya River Basin; Zeravshan and Varzob Rivers (Tajikistan); has been found also on *Capoeta damascina* in the Sea of Galilee in Israel.

5 (4). The length of the copulatory organ is less than 0.040 mm.

6 (7). The length of the dorsal bar is less than 0.045 mm.
D. mokhayeri Jalali et Molnar, 1990 (Fig. 342)

These are minute worms; body is 0.3–0.4 mm long and 0.08–0.086 mm wide. Length of marginal hooks is 0.020–0.024 mm. Ventro-apical length of anchors is 0.042–0.044 mm, dorso-apical length 0.031–0.034 mm, inner root 0.0035–0.004 mm, outer root 0.008–0.009 mm, sharp bent end of point 0.0085 mm. Size of dorsal bar is 0.004–0.005 (in the middle) and 0.009–0.010 (at the ends) x 0.0425 mm. Length of copulatory organ is 0.0305 mm, accessory piece 0.030 mm. Vaginal armament is absent.

Found on gill filaments (site is not mentioned in the description) of *Aspius vorax*; Dez River, Gulf Basin (Iran).

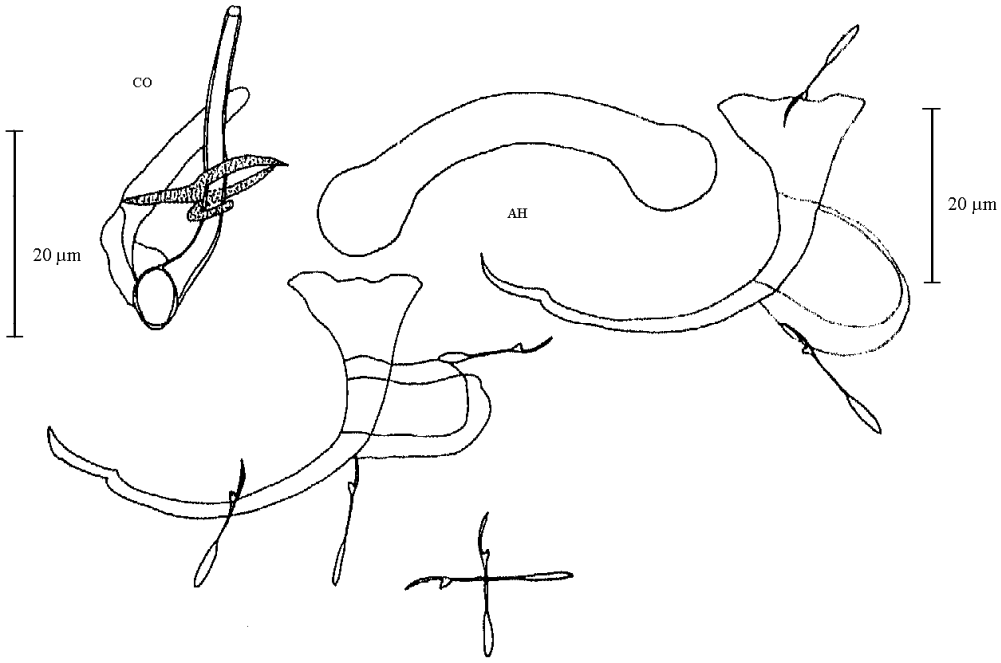
7 (6). The dorsal bar is greater than 0.045 mm long.
D. molnari Jalali, 1992 (Fig. 343)

Body length is 0.45–0.5 mm, width 0.12–0.14 mm. Length of marginal hooks is 0.018–0.022 mm. The anchors have less developed roots and a point with a sharp bent end. Ventro-apical length of anchors is 0.046–0.051 mm, dorso-apical length 0.028–0.033 mm, sharp bent end of point 0.008 mm. Size of dorsal bar is 0.004–0.005 mm (in the middle) and 0.008–0.012 (at the ends) x 0.046–0.060 mm. Length of copulatory organ is 0.031–0.036 mm. Vaginal armament is absent.

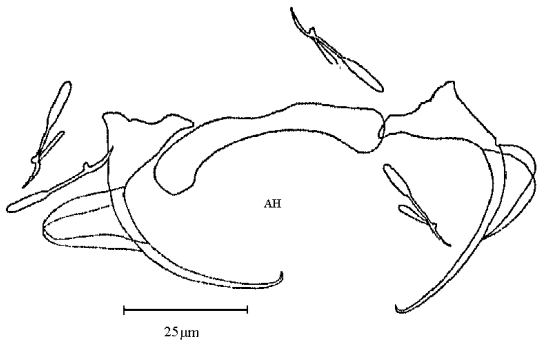
Found on gill filaments of *Cyprinion macrostomum*; Dez River (Iran).

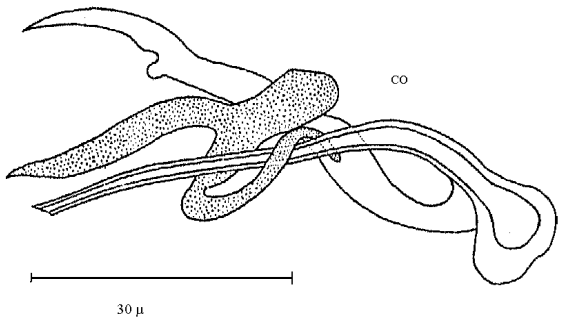
8 (1). The anchors lack a sharp bent end of the point.
D. persicus Molnar et Jalali, 1992 (Fig. 344)

Length of marginal hooks is 0.023–0.025 mm. Ventro-apical length of anchors is 0.050–0.060 mm, dorso-apical length 0.035–0.051 mm, inner root 0.011–0.013 mm, outer root 0.005 mm. Size of dorsal bar is 0.005–0.0065 (in the middle) and 0.008–0.011 (at the ends) x 0.046–0.053 mm.



343





344

Fig. 343 – 344.
343 - *Dogielius molnari* (after Jalali, 1992). **344 -** *Dogielius persicus* (after Molnar et Jalali, 1992).

Length of copulatory organ is 0.043–0.072 mm. Vaginal armament is in the form of spherical disc with a short bent tube; disc diameter 0.017–0.026 mm, tube length 0.017–0.035 mm.

Found on gill filaments of *Barbus grypus*, *B. sharpeyi*, and *B. luteus*; Dez and Karun Rivers (Iran).

Genus *Bivaginogyrus* Gussev et Gerasev, 1986

These Dactylogyridae have a spindle-like body, a broad haptor, and two pairs of head lobes. The integument forms wrinkles, which become less pronounced at the anterior end. Two pairs of eyes are present. The haptor has seven pairs of marginal hooks, one pair of needle-shaped structures, one pair of anchors without an outer root (their points lie opposite one another), and a dorsal and ventral bar; the latter is twice as large as the dorsal bar. The intestine has caeca that merge posteriorly to form a ring. There are two vaginal ducts that open on each side of the body (dorso-laterally) and form cup-shaped structures. These ducts begin from the ootype. Other structures are the same as in other Dactylogyridae.

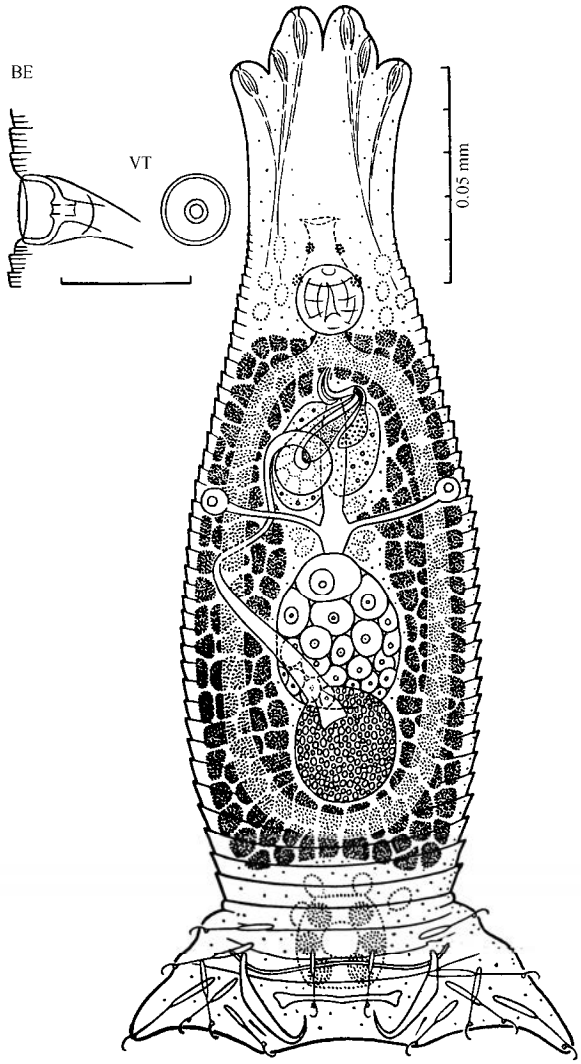


Fig. 345 - *Bivaginogyrus obscurus*, dorsal view (after Gussev and Gerasev, 1986).

Found on gill filaments of cyprinid fishes from the Amur River.

The type and single species of genus *Bivaginogyrus* is *B. obscurus* (Gussev, 1955).

B. obscurus (Gussev, 1955) (Fig. 345, 346)

Syn.: *Dactylogyrus obscurus* Gussev, 1955

These are minute worms; body can be up to 0.30 mm long and 0.08 mm wide. Length of marginal hooks is 0.014–0.029 mm. Length of anchors is 0.022–0.025 mm, main part 0.017–0.020 mm, inner root 0.008 mm, point 0.009–0.010 mm. Size of dorsal bar is 0.002–0.003 x 0.021–0.031 mm, **{**- or **W**-shaped ventral bar 0.001 x 0.045–0.052 mm. Length of copulatory organ is 0.013–0.017 mm. Vaginal armament consists of two cup-like structures; their diameter is about 0.005–0.006 mm.

Found on gill filaments of *Pseudorasbora parva*; it embraces the filaments using the anchors and the V pair of rather long marginal hooks; Amur River Basin (Russia); now many water bodies of

Central Asia and Kazakhstan where parasites have been brought with their host, which is now widely distributed in the eastern Palaearctic; this species also may be found in European water bodies; Liao He and Yangtze Rivers (China).

Fig. 346 - *Bivaginogyrus obscurus* (after Gussev, 1955a).

Genus *Markewitschiana* Allamuratov et Koval, 1966

These Dactylogyridae are small; length can be up to 0.5 mm. They have a poorly developed haptor equipped with seven pairs of marginal hooks, one pair of needle-shaped structures, and a cruciform bar. Most have four eyes, but sometimes many scattered pigment granules are present. The integument is rather thick (up to 0.002 mm). Two intestinal caeca are confluent posteriorly. The ovary and testis are oval. The copulatory organ consists of a tube and accessory piece. A tube-shaped vaginal armament is present.

These are parasites of the nasal cavities of Central Asian and Transcaucasian fishes.

The type species is *M. crucifera* Allamuratov et Koval, 1966.

Key to species of the genus *Markewitschiana*

1 (2). The posterior projection of the bar has a bifurcation in the form of denticles. Two rod-like structures near the posterior projection are absent.

M. crucifera Allamuratov et Koval, 1966 (Fig. 347)

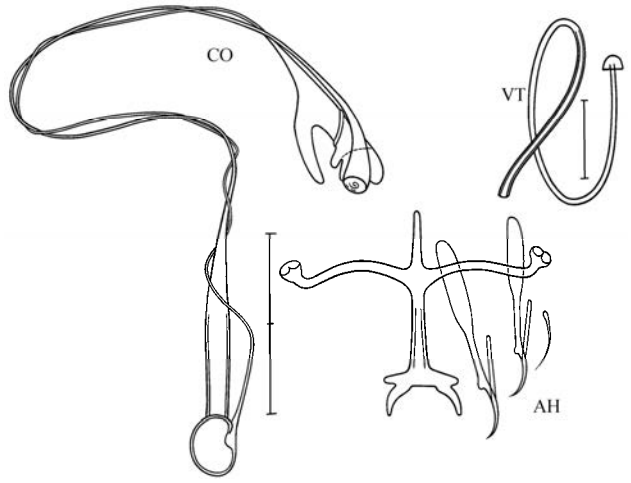


Fig. 347 - *Markewitschiana crucifera*.

The body is longitudinal and narrowed at both ends; length up to 0.5 mm, width 0.097 mm. Length of marginal hooks is 0.011–0.027 mm, bar 0.018–0.024 x 0.028–0.034 mm; the posterior projection has a bifurcation in the form of denticles. Total length of copulatory organ is 0.049–0.069 mm; tube along the curve 0.063–0.085 mm, diameter of initial bubble-shaped part 0.005 mm, then along 0.010–0.015 mm of length the tube is the almost cylindrical (diameter of about 0.0025 mm) and then becomes filiform. The vaginal armament forms a loop; its length is 0.048–0.064 mm, diameter about 0.001 mm.

Found in nasal cavities of *Capoeta capoeta heratensis*, *Luciobarbus capito conocephalus*, and *Schizothorax intermedius*; water bodies of Uzbekistan and Tajikistan.

2 (1). The posterior projection of the bar lacks bifurcation in the form of denticles. Two rod-like structures are present near the posterior projection.

M. triaxonis Matsaberidze, 1991a (Fig. 348).

These are minute worms; body can be up to 0.45 mm long and 0.1 mm wide. Length of marginal hooks is 0.022–0.027 mm, bar 0.021 x 0.022 mm. According to the original description, the bar is rachis-like with three projections at the anterior end. From this point of view it corresponds to the posterior projection of the bar of *M. crucifera* and is situated longitudinally. Rod-like structures are 0.004–0.005 mm long. Total length of copulatory organ is 0.093 mm; tube along the curve 0.135 mm, diameter of initial bubble-shaped part 0.009 x 0.007 mm, then along about 0.024 mm of length the tube is almost cylindrical and then becomes filiform. A sclerotized irregular-shaped structure is situated beside the copulatory organ, which is connected to the end of the accessory piece by muscle fibres. The vaginal armament forms a loop; its length is 0.071 mm, diameter about 0.0015 mm.

Found in nasal cavities of *Barbus barbus* (type host), *Capoeta capoeta*, and *Squalius cephalus*; Aragvi River (Georgia).

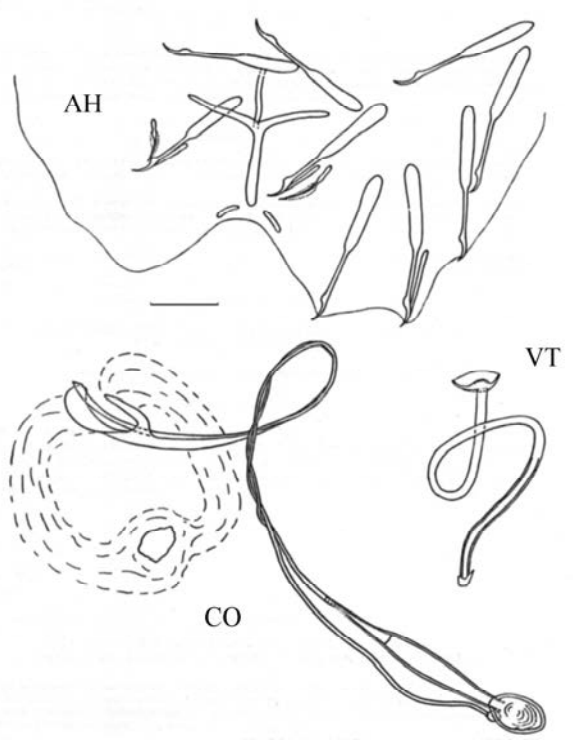


Fig. 348 - *Markewitschiana triaxonis* (after Matsaberidze, 1991a).

Genus *Acolpenteron* Fischthal et Allison, 1940

These Dactylogyridae are medium size and have an elongated body that is rounded at the anterior end. They may or may not have four eyes; in some cases scattered pigment granules are present. The folded integument is rather thick (up to 0.003 mm); in some cases papillae bearing sensitive cilia (?) are dispersed over the body. The haptor is poorly developed and has seven pairs of marginal hooks and a pair of needle-shaped structures. Two intestinal caeca are confluent posteriorly, and they lack projections. The ovary is oval shaped and located in the middle of the body; the single elongated testis is behind it. The spermaduct turns around the left intestinal caecum or passes between the caeca; it goes around two reservoirs of prostatic glands and forms a bubble or seminal vesicle at its end. The copulatory organ has a tube and an accessory piece. The vaginal duct opens ventrally near the right margin.

These are parasites of the ureters and urinary bladder of North American and Palaearctic freshwater fishes (Cypriniformes and, more rarely, Centrarchidae). They are found on two species of Cyprinidae from the Amur River.

The type species is *A. ureteroecetes* Fischthal and Alison, 1940 from Lake Michigan, USA from the ureters and urinary bladder of *Micropterus salmoides* and *M. dolomieu* (Centrarchidae).[66]

Key to species of the genus *Acolpenteron*

[66] The mortality of young *Micropterus salmoides* (Centrarchidae) cultured in South Africa caused by heavy infection with *Acolpenteron ureteroecetes* is to be noted (Plessis, 1948).

1 (2). The copulatory tube is straight and more than 0.060 mm long; its initial part is of bubble shaped; the accessory piece is of the "anchoratus" type.
A. nephriticum Gvosdev, 1945 (Fig. 349, 350, 351)[67]

These are medium or large worms; body can be up to 0.9 mm long and 0.25 mm wide. Length of marginal hooks is 0.015–0.019 mm; they are situated in two incomplete circles and form an ∞-like figure (based on the original description). Length of copulatory tube is 0.061–0.068 mm, diameter in the middle about 0.004 mm.

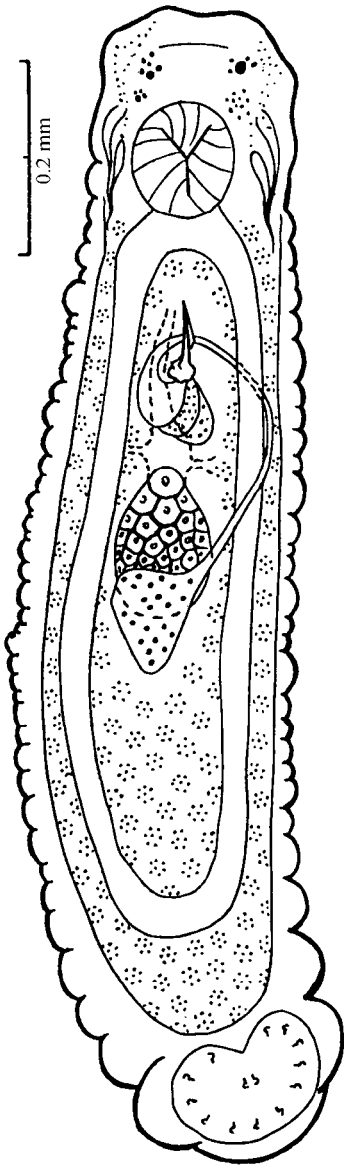
Found in ureters of *Triplophysa strauchi* and *T. dorsalis*. Found in ponds and some small rivers in suburbs of Alma-Ata (Balkhash-Ili Basin, Kazakhstan).

2 (1). The copulatory tube is sickle shaped; the length along the curve is less than 0.55 mm; its initial part is slightly broadened; the accessory piece has a gutter-shaped end and a projection. These are parasites of the genera *Rhodeus* and *Acanthorhodeus*.
A. petruschewskyi Strelkov, 1962 (Fig. 352)

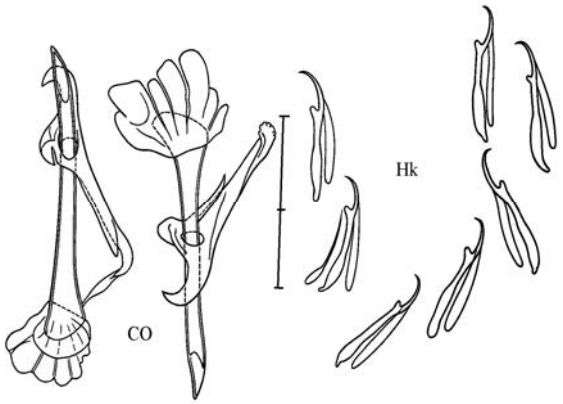
These are large worms; body can be up to 1.1 mm long and 0.18 mm wide. Length of marginal hooks is 0.016–0.019 mm; they are situated at the posterior margin of the haptor. Length of copulatory tube along the curve is 0.035–0.051 mm, diameter in the middle 0.003–0.005 mm. Vaginal armament is a short tube between the body margin and the midline.

Found in ureters of *Rhodeus sericeus* and *Acanthorhodeus asmussi*; Zeya River (a tributary of the Amur River, Russia).

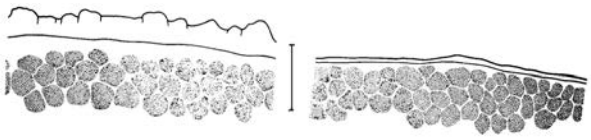
[67] Numerous *A. nephriticum* (up to 30 specimens per fish) have been found in small rivers that run into lake Alakol' (East Kazakhstan) (personal communication of Kartunova).



349



350



351

Fig. 349 – 351.
349 - *Acolpenteron nephriticum*, ventral view. **350 -** *Acolpenteron nephriticum*. **351 -** Tegument of *Acolpenteron nephriticum* (left) and *Pseudacolpenteron pavlovskii* (right).

Genus *Pseudacolpenteron* Bychowsky et Gussev, 1955

These small or medium size Dactylogyridae have a well-developed haptor. The integument is not thick (less than 0.001 mm). Two pairs of eye spots are present in the adult. The haptor has seven pairs of marginal hooks and one pair of needle-shaped structures only. The intestinal caeca are confluent posteriorly. The genital system is the same as for the family: the chitinoid copulatory organ consists of a tube and an accessory piece, and the vaginal armament is absent.

Found on skin, fins, and gills and in nasal cavity of freshwater Cyprinidae. The genus consists of two species.

The type species is *P. pavlovskii* Bychowsky et Gussev, 1955.

Key to species of the genus *Pseudacolpenteron*

1 (2). The copulatory tube is short and bent into a semicircle.
P. pavlovskii Bychowsky et Gussev, 1955 (Fig. 351, 353)

These are small or medium size worms; body can be up to 0.67 mm long and 0.22 mm wide. Length of marginal hooks is 0.023–0.037 mm. Total length of copulatory organ is 0.038–0.056 mm, length of tube along the curve can be up to 0.060 mm, diameter 0.002 mm. Vaginal armament is absent.

Found on fins and gill filaments and in nasal cavities of *Cyprinus carpio* and *C. c. rubrofuscus*; North Caucasus, Danube River Basin, water bodies of Central Asia and Kazakhstan. Osmanov (1971) found it accidentally on *Luciobarbus brachycephalus*, *L. capito conocephalus*, *Capoeta capoeta heratensis*, *Ctenopharyngodon idella*, and *Leuciscus idus oxianus*. It has been also found in Poland, Bulgaria, Israel, and the USA; it was surely brought to the USA with *Cyprinus carpio* from Europe.

2 (1). The long copulatory tube forms about two loops.
P. ignotus (Gussev, 1955) (Fig. 354).
Syn.: *Acolpenteron ignotus* Gussev, 1955

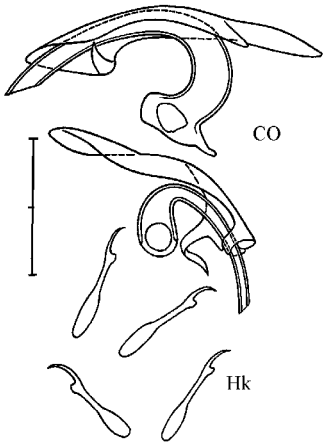
These small worms have a body size up to 0.54 mm length and 0.1 mm width. Length of marginal hooks is 0.013–0.017 mm. Total length of copulatory organ can be up to 0.046 mm, length of tube along the curve up to 0.19 mm, diameter 0.001–0.002 mm, accessory piece 0.050–0.068 mm. The vaginal duct has a thin chitinoid lining 0.040–0.058 mm long, diameter 0.001 mm.

Found on gill filaments of *Acanthorhodeus asmussi*; Lake Khanka (Russia).

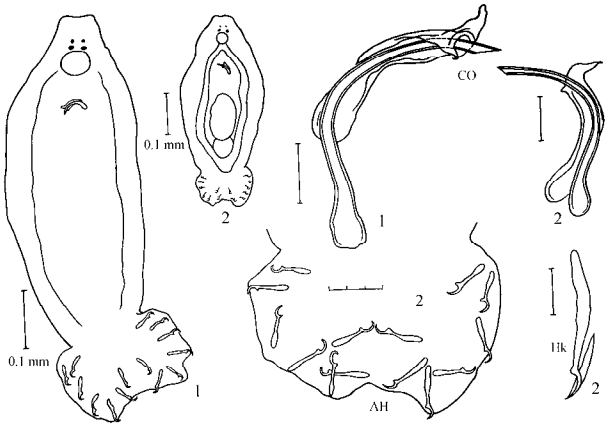
Family Ancyrocephalidae Bychowsky, 1937[68]

These Dactylogyridea (Dactylogyrinea) have an elongated and sometimes wide leaf-shaped body (length 0.1–2.0 mm, rarely more) and 2–3 pairs of glandular lobes on the head, which sometimes are smooth or form two cylindrical structures. In some cases the haptor is saucer shaped. Seven pairs of marginal hooks are present (in some cases with 1–2 pairs of needle-like structures). In most cases two pairs of anchors, which may be similar or different in size and form, and usually two bars are present. In this family, a tendency of decreased number of anchors and bars is observed. Sometimes the anchors and bars have disappeared, or the bars are divided into two parts. The bars are connected with a ventral or dorsal pair of anchors, and sometimes the bars are connected or merged to one another along their middle parts. In some cases the anchors have patches. In most cases two pairs of eyes are present, but in some cases they are absent. The intestinal caeca may or may not be confluent posteriorly, and sometimes they have lateral projections. The ovary is rounded or elongated, rarely with lobes, and it is situated between the intestinal caeca before the testis; sometimes it loops around the right caecum.

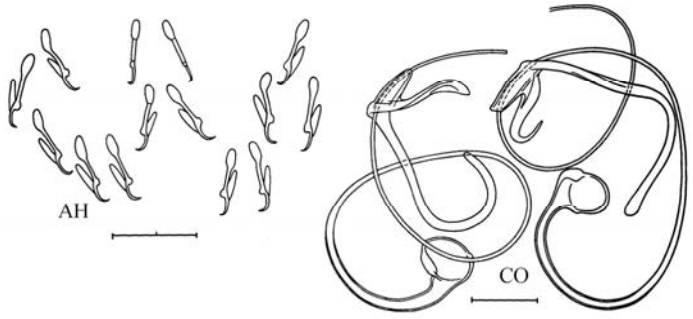
[68] For the last review on Ancyrocephalidae taxonomy see Kritsky et Boeger (1989) and Simkova et al. (2003).



352



353



354

Fig. 352 – 354.

352 - *Acolpenteron petruschewskyi* (after Strelkov, 1962). **353 -** *Pseudacolpenteron pavlovskii* (after Bychowsky et Gussev, 1955): 1 – total view and copulatory organ of specimen from Volga River, 2 – total view, copulatory organ and haptor armament of specimen from Northern Caucasia rivers. **354 -** *Pseudacolpenteron ignotus* (after Gussev, 1955a).

The single vaginal duct often has chitinous armament, but in some cases it is absent or not visible. It usually opens dextrally; in rare cases the opening is sinistral or median. Only one testis is present, which in rare cases is divided into two or more parts. The spermaduct loops around the left intestinal caecum or passes between the caeca. The seminal vesicle is a broadening of the spermaduct or a blind projection of it. The copulatory organ consists of a tube and an accessory piece, but the latter is sometimes absent. One or two prostatic reservoirs are present.

These are parasites of marine and freshwater bony fishes, in most cases of Perciformes and Siluriformes. They usually are gill parasites, but in rare cases they infect the fish's stomach. The family which may be a polyphyletic taxon contains more than 120 genera in five subfamilies: Ancyrocephalinae, Ancylodiscoidinae, Pseudomurraytrematinae, Linquadactylinae, and Hareocephalinae. The subfamilies Heteronchocleidinae, Anacanthorinae, and Curvianchoratinae were described previously, but the first was described erroneously and the descriptions of the second and third seem doubtful (Gussev, 1977, 1978b).

Representatives of first three subfamilies have been found in freshwater, but representatives of only the first two have been reported from freshwaters of the Palaearctic and Amur regions. The subfamily Linquadactyloidinae Thatcher et Kritsky, 1983 was described for a species found on a characine fish of South America.

Subfamily Ancyrocephalinae Bychowsky, 1937

The diagnosis of members of this subfamily is very similar to that of the family except for one feature: the ovary lies between the intestinal caeca and does not loop around one caecum. In addition, the head lobes (especially in large species) are poorly visible and the anterior end of the body is triangular or trapeziform. The anchors lack patches.

In most cases the Ancyrocephalinae are gill parasites (in rare cases they are intestinal parasites) of marine and freshwater bony fish, mostly Perciformes.

About 20 species in 3–4 genera have been found in freshwaters of the Palaearctic. Many genera and species have been described from Africa, South Asia, and South and North America.

As has been noted many times (Gussev, 1955a, 1978b; Bychowsky, 1957a; Bychowsky and Nagibina 1970, 1978 and others) the system of this subfamily is poor developed. Morphological analysis (Kritsky et Boeger, 1989) and molecular data on a few species of the subfamily confirmed non-monophyly of the Ancyrocephalinae (Simkova et al., 2003).

Bychowsky et Nagibina (1970) stated that only two species (now three) can be attributed to the genus *Ancyrocephalus* sensu stricto without doubt. Nevertheless, we have retained the former group of *Ancyrocephalus* (s. l.) as well as the type species of the genus *Ancyrocephalus* (s. str.) within this group until future revision is conducted. This is not a problem for this Key because its main task is identification of species. Therefore, different "genera" are included in the key of this group. Some other genera and species from introduced fish are included in the Supplement. The genus *Ligophorus* is not included in the Supplement until its modern revision.

Key to species of *Ancyrocephalus* (s. l.) group

1 (12). The length of the copulatory tube is greater than 0.070 mm.

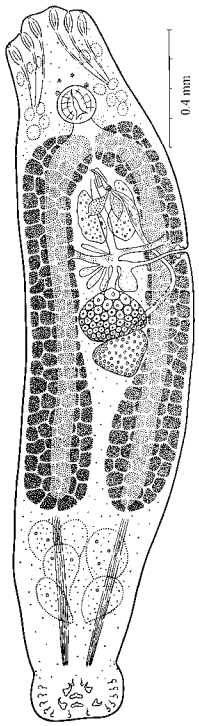
2 (7). The copulatory tube is massive and **S**-shaped; its diameter is greater than 0.003 mm in the middle; the initial part is elongated and rectangular; the accessory piece resembles a triangular shield. The anchors have a very broad main part and a short point. The intestinal caeca are confluent posteriorly.

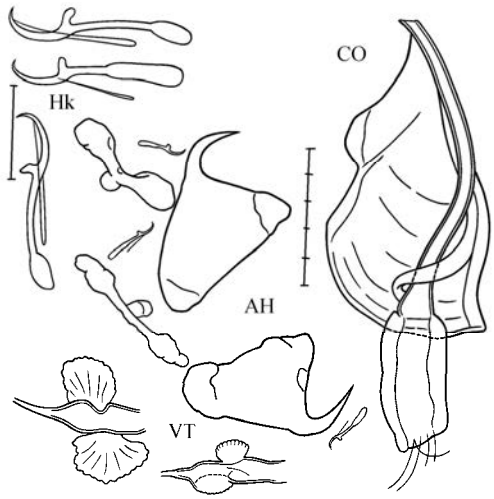
3 (4). The length of copulatory tube is greater than 0.13 mm; its diameter is greater than 0.005 mm in the middle.

A. paradoxus Creplin, 1839 (Fig. 355, 356)
Syn.: *Gyrodactylus crassiusculus* Wedl, 1857

These very large worms have a body length that can be up to 4.7 mm and width to 0.8 mm. Length of marginal hooks (with a small handle) is 0.017–0.020 mm. Both pairs of anchors are similar in form and may or may not have poorly developed roots; total length of anchors[69] is 0.050–0.063 mm. Size of ventral bar is 0.009–0.014 x 0.045–0.06 mm, dorsal bar 0.008–0.012 x 0.060–0.070 mm (both with a projection in the middle). Total length of copulatory organ is 0.13–0.16 mm, diameter of tube 0.006–0.010 mm, width of accessory piece up to 0.070 mm. Length of vaginal tube is 0.040–0.050 mm, diameter about 0.010 mm, comb-shaped outgrowths up to 0.020 mm.

Found on gill filaments of *Sander luciopercae, Perca fluviatilis, and Esox lucius* (?); everywhere in pike-perch area.





355 **356**

Fig. 355 – 356.
355- *Ancyrocephalus paradoxus* (ventral view). **356 -** *Ancyrocephalus paradoxus* from Latorica River (Slovakia).

[69] Distance between the point bend and the farthest top of any root.

4 (3). The copulatory tube is not longer than 0.11 mm; diameter up to 0.004 mm.

5 (6). The vaginal tube has comb-shaped growths on its walls.
A. percae Ergens, 1966 (Fig. 357)
Syn.: *A. paradoxus* Creplin, 1839, part.; *Dactylogyrus unguiculatus* (uncinatus) Wagener, 1857

These are large worms; body length can be up to 1.8 mm and width to 0.4 mm. Length of marginal hooks is 0.016–0.019 mm. The anchors have poorly developed roots; total length is 0.049–0.061 mm. Bars have a poorly visible broadening in the middle: ventral bar 0.008–0.010 x 0.036–0.040 mm, dorsal bar 0.005–0.008 x 0.040–0.050 mm. Length of copulatory organ is 0.070–0.090 mm; diameter of tube about 0.003 mm, width of accessory piece 0.020 mm.

Found on gill filaments of *Perca fluviatilis* and *Sander lucioperca*e; distributed in the basins of the Danube, Elbe, and Oder Rivers in the west to water bodies of the Kola Peninsula and the Pechora River in the north to the Yenisey and Selenga Rivers in the east; its distribution may be even broader.

6 (5). The vaginal tube lacks growths and has a small swelling in the middle.
A. gussevi Dontsov, 1972 (Fig. 358)
Syn.: *A. paradoxus* Creplin, 1839, part.

These are large worms; body length can be up to 3.7 mm and width to 0.5 mm. Length of marginal hooks is 0.017–0.019 mm. Total length of anchors is 0.049–0.062 mm. Bars have an anterior projection in the middle: ventral bar 0.008–0.010 x 0.042–0.057 mm, dorsal bar 0.010–0.014 x 0.040–0.065 mm. Length of copulatory organ is 0.085–0.11, diameter of tube about 0.004, width of accessory piece 0.029–0.030 mm. Length of vaginal tube is 0.023-0.030 mm.

Found on gill filaments of *Sander volgensis*; to date it has been found only in the Volga River and in the basins of the Danube (Slovakia) and Tisa (Ukraine) Rivers.

7 (2). The copulatory tube is extremely thin, filiform, and curved to form a loop; its diameter is less than 0.001 mm; its initial part is bubble shaped. The intestinal caeca are confluent posteriorly (although in some cases this may not be true).

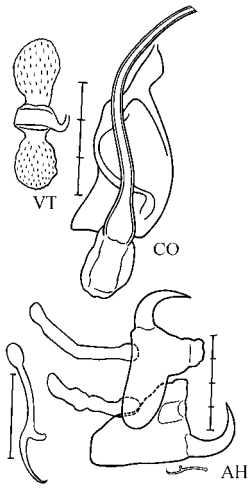
8 (9). The accessory piece of the copulatory organ is not connected to the initial part of the tube and is situated at its distal end. A curious chitinoid beak-shaped structure is present near the vaginal armament.

A. mogurndae (Yamaguti, 1940) (Fig. 359)
Syn.: *Haliotrema mogurndae* Yamaguti, 1940; *Tetraonchus dispar* Dogiel, 1947

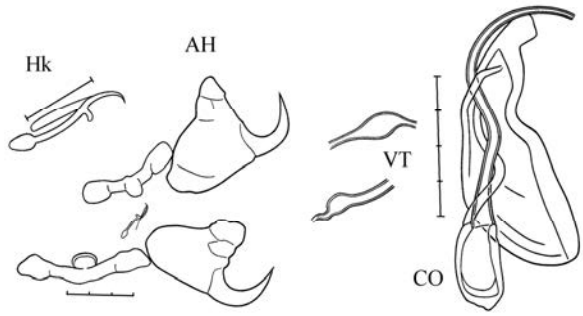
These small or medium size worms have a body length up to 0.6 mm and width to 0.13 mm. Marginal hooks are of the larval type, length 0.015–0.019 mm. Total length of ventral anchors is 0.050–0.055 mm, dorsal anchors 0.059–0.060 mm. Ventral bar is 0.008–0.010 x 0.052–0.064 mm, dorsal bar 0.009–0.013 x 0.057–0.071 mm. Length of copulatory tube, which forms several loops, is 0.510–0.590 mm, diameter of initial part about 0.015 mm, length of accessory piece 0.036–0.041 mm. The vaginal tube is curved and forms a ball of diameter about 0.017 mm; length of the tube along the curve is about 0.26 mm. The first description states that the intestinal caeca are blindly closed, but this can be revised.

Found on gill filaments of *Siniperca chuatsi*; Amur River Basin; described from Japan from gills of *Odontobutis obscura*; in Yangtze River from gills of *Gymnogobius urotaenia*.

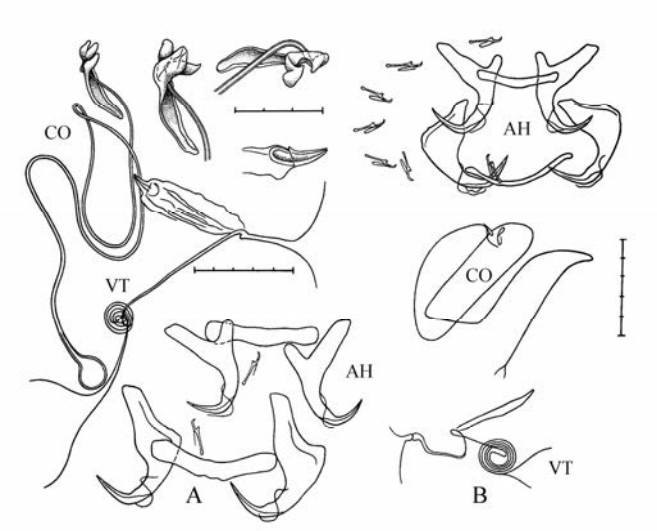
9 (8). The accessory piece is situated near the initial part of the tube and is connected with it. The beak-shaped organ is absent. The intestinal caeca are confluent posteriorly.



357



358



359

Fig. 357 – 359.
357 - *Ancyrocephalus percae* from Pechora River. **358 -** *Ancyrocephalus gussevi* from Latorica River (Slovakia). **359 -** *Ancyrocephalus mogurndae,* A – adult specimen, B – immature specimen.

10 (11). The largest of the marginal hooks are not longer than 0.025 mm. The short accessory piece of the copulatory organ is triangular; the initial part of the copulatory tube lacks a growth.
A. subaequalis Akhmerov, 1952 (Fig. 360)
Syn.: *A. pavlovskyi* f."A" Gussev, 1955

These are small worms; body length is up to 0.45 m and width to 0.10 mm. Length of marginal hooks is 0.013 (I–II pairs) – 0.025 (III–VII pairs) mm. Total length of ventral anchors is 0.035–0.045 mm, dorsal anchors 0.037–0.051 mm. Ventral bar is 0.004–0.009 x 0.025–0.030 mm, dorsal bar 0.006–0.009 x 0.024–0.030 mm. Length of copulatory tube is 0.13–0.17 mm, diameter of its initial part is about 0.009 mm. Length of accessory piece is about 0.010 mm. The vaginal tube is filiform with a diameter less than 0.001 mm.

Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin. It also was described by Akhmerov (1952) from *Ctenopharyngodon idella* (accidental find).

11 (10). The largest marginal hooks are greater than 0.28 mm. The accessory piece of the copulatory tube is ribbon shaped; the initial part of the tube has a massive growth.
A. pavlovskyi Gussev, 1955 (Fig. 361)
Syn.: *A. pavlovskyi* f. typica Gussev, 1955

These are small worms; body length can be up to 0.45 mm and width to 0.10 mm. The III–VII pairs of marginal hooks have a well-marked handle and pivot, length 0.029–0.033 mm. The I–II pairs of marginal hooks are of the larval type, length 0.013–0.014 mm. Total length of ventral anchors is 0.045–0.056 mm, dorsal anchors 0.046–0.056 mm. Ventral bar is 0.006–0.008 x 0.023–0.029 mm, dorsal bar 0.006 x 0.025–0.029 mm. Length of copulatory tube is 0.14–0.16 mm, diameter less than 0.001 mm, diameter of the initial part about 0.007 mm. The accessory piece is ribbon shaped, with a length of about 0.045 mm. The vaginal tube is thin and about 0.12 mm long.

Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin.

12 (1). The copulatory tube is less than 0.065 mm.

13 (14). The copulatory tube is sickle shaped.
A. pseudorasborae Akhmerov, 1952 (Fig. 362)

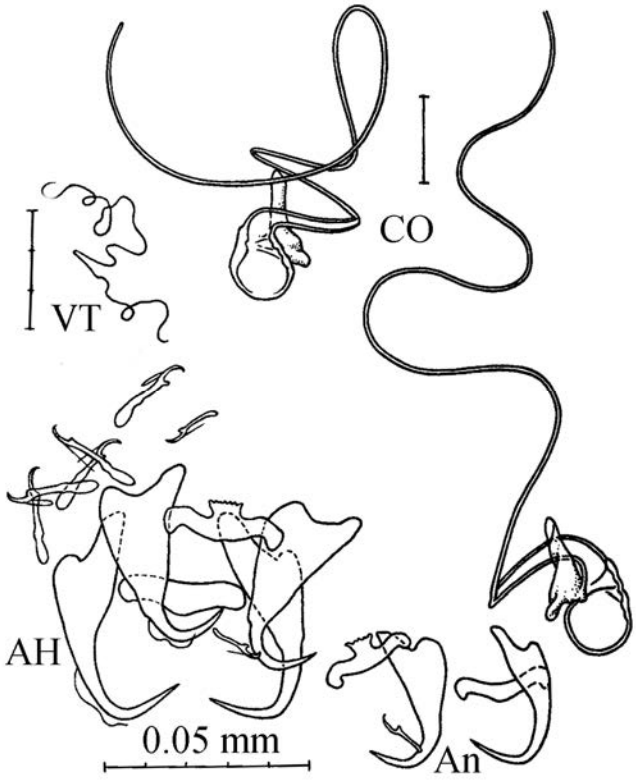
These are small worms; body can be up to 0.35 mm, width to 0.08 mm. Marginal hooks are of the larval type, length about 0.012 mm. The main part of the ventral anchors is broader than the same part of the dorsal anchors. Total length of ventral anchors is 0.020–0.025 mm, dorsal anchors 0.023–0.028 mm. Ventral bar is 0.003–0.004 x 0.025–0.029 mm, dorsal bar 0.003–0.004 x 0.017–0.022 mm. Total length of copulatory organ is 0.025–0.034 mm, tube along the curve 0.050–0.061 mm; length of accessory piece 0.021–0.029 mm. Length of the ansiform vaginal tube is 0.025–0.030 mm.

Found on gill filaments of *Pseudorasbora parva*; Amur and Suifun Rivers (Russia); Liao He and Yangtze Rivers (China).

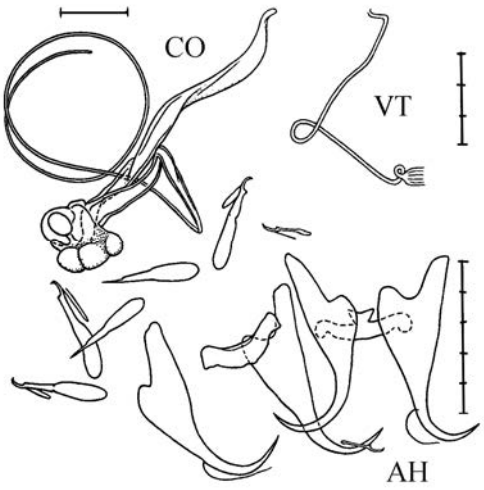
14 (13). The copulatory tube is weakly bent.

15 (34). All marginal hooks have blades of the same length; the heel protrudes.

16 (21). The marginal hooks of the I and III–VII pairs or only the III–VII pairs have a well-developed and thickened handle of the *Dactylogyrus* type; hooks of the II or I–II pairs have a small handle nearer to the larval type.



360



361

Fig. 360-361
360- *Ancyrocephalus subaequalis.* **361** - *Ancyrocephalus pavlovskyi*

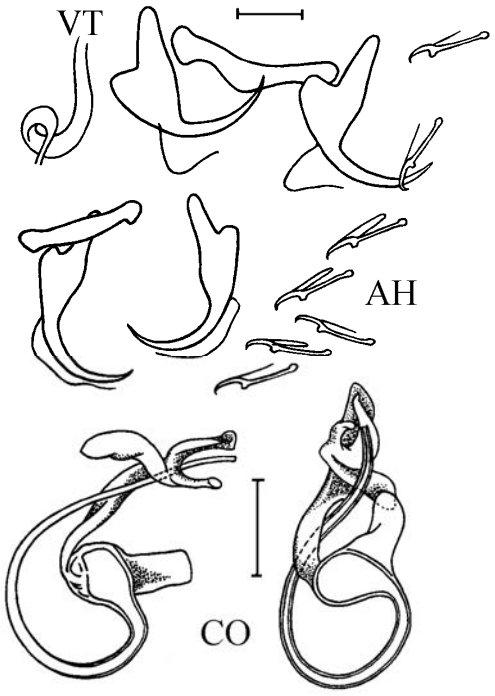


Fig. 362 - *Ancyrocephalus pseudorasborae*.

17 (20). The marginal hooks of the II pair only have a small larval-type handle; anchors have opened points.

18 (19). The copulatory tube tapers to the end. Vaginal armament is present.
A. hemibarbi Akhmerov, 1952 (Fig. 363)

These are small worms; body length can be up to 0.40 mm and width to 0.09 mm. Length of marginal hooks of the I and III–VII pairs is 0.025–0.039 mm, II pair about 0.017 mm. The anchors are of similar form; total length of ventral anchors is 0.041–0.062 mm, dorsal anchors 0.048–0.080 mm. Ventral bar is 0.006–0.008 x 0.029–0.041 mm, dorsal bar 0.006–0.012 x 0.031–0.041 mm. Total length of copulatory organ is 0.043–0.049 mm. The vaginal armament resembles a short bent tube with a bubble about 0.025 mm in diameter.

Found on gill filaments of *Hemibarbus labeo* and *H. maculates*; Amur River Basin.

19 (18). The copulatory tube is slightly broader at its end. Vaginal armament is absent.
A. skrjabini Gussev, 1955 (Fig. 364)

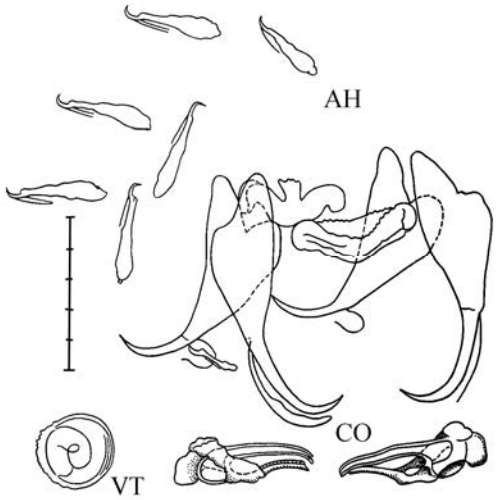
These are small worms; body length can be up to 0.35 mm and width to 0.05 mm. Length of marginal hooks of the I and III–VII pairs is 0.033–0.037 mm, II pair 0.016–0.019 mm. Total length of ventral anchors is 0.058–0.061 mm, dorsal anchors 0.078–0.080 mm. Ventral bar is 0.008–0.011 x 0.037 mm, dorsal bar 0.013–0.014 x 0.039–0.041 mm. Length of copulatory organ is 0.043 mm.

Found on gill filaments of *Hemibarbus labeo*; Lake Khanka (Russia).

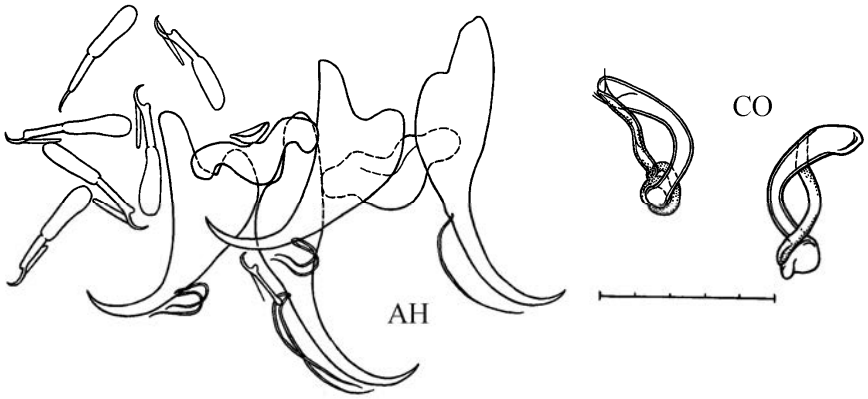
20 (17). The marginal hooks of the I–II pairs have a small handle that is of the larval type; anchors have a curved point. These are parasites of American cat fishes.
A. (=Ligictaluridus) pricei Mueller, 1936 (Fig. 365, 366)

These are small worms; body length can be up to 0.4 mm and width to 0.08 mm. Length of marginal hooks of the I–II pairs is 0.013–0.014 mm, III–VII pairs 0.017–0.018 mm. Both pairs of anchors are variable; mostly without an outer root; the ventral pair is slightly thicker and longer than the dorsal pair. Length of ventral anchors 0.042–0.050 mm, main part 0.041–0.043 mm, inner root 0.012–0.014 mm, point 0.017–0.019 mm. Length of dorsal anchors is 0.040–0.046 mm, main part 0.038–0.040 mm, inner root 0.010–0.013 mm, point 0.015–0.017 mm. Ventral bar is 0.007–0.010 x 0.034–0.036 mm, dorsal bar 0.010–.013 x 0.040–0.043 mm. Total length of copulatory organ is 0.027–0.036 mm.

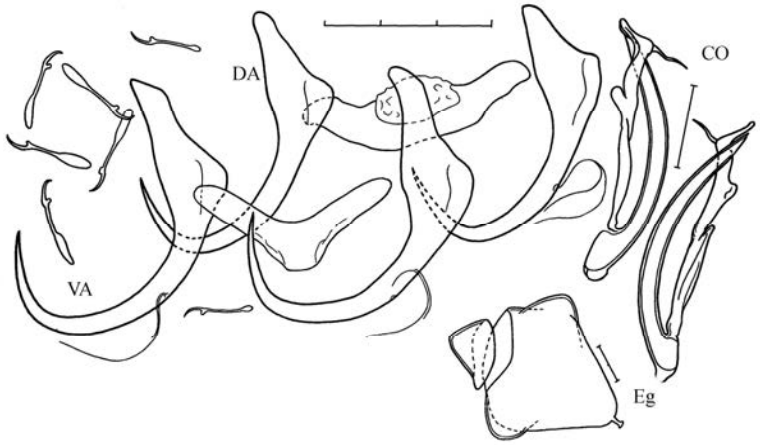
Found on gill filaments of American *Ameiurus nebulosus* and *Ictalurus punctatus*. In 1885 the first species was brought from North America to several water bodies of Poland; now it has spread to the Danube River Basin and other rivers of Central and West Europe; a second species is now cultured in fish farms of the southern part of Russia, Ukraine, and other European states. Another species *A.* (*=Ligictaluridus) monticellii* (Cognetti de Martiis, 1924) described from northwestern Italy was found on *Ameiurus catus* in northwestern Poland (Prost, 1973); it was in the nasal cavities rather than on the gills. The drawing in the original description of *A.* (*=Ligictaluridus) monticellii* is rather poor and the copulatory organ is absent from the drawing. If she was correct in her identification, Prost's drawings and description shows that *A.* (*=Ligictaluridus) monticelli* is similar to *A. (=Ligictaluridus) pricei*, but its body is larger, the anchors and bars are larger, and the copulatory tube is wider and longer (Fig. 367). According to Prost (1973), body length can be up to 1.02 mm; length of marginal hooks is 0.020–0.022 mm, ventral anchors 0.078–0.079 mm, ventral bar 0.012–0.015 (at the ends)–0.023 (in the middle) x 0.083 mm, dorsal anchors 0.063 mm, dorsal bar 0.025 (at ends) x 0.015–0.016 (in the middle) x 0.072 mm; length of the copulatory organ is 0.056–0.062 mm. Specimens from *Ameiurus nebulosus* from the Tisa River are similar to *L. monticellii*, but the chitinoid structures are smaller (Fig. 366). Both pairs of anchors also have a small outer root, like specimens from Poland.



363



364



365

Fig. 363 – 365.
363 - *Ancyrocephalus hemibarbi.* **364 -** *Ancyrocephalus skrjabini.* **365 -** *Ancyrocephalus (=Ligictaluridus) pricei* from Tisa River.

21 (16). All marginal hooks are of the larval type; the handle looks like a bulge at the end of a pivot.

22 (25). The accessory piece of the copulatory tube lacks long projections and is in the form of a gutter-shaped simple plate that is broadened at its end with a claw-shaped jag.

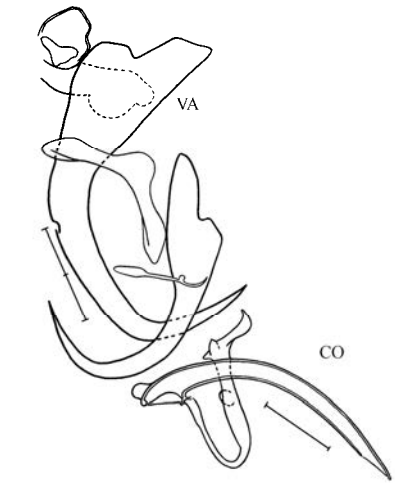
23 (24). Both pairs of anchors are of the same shape and have well-developed roots. The copulatory tube is bent like a sabre.

A. cruciatus (Wedl, 1857) (Fig. 368, 369)

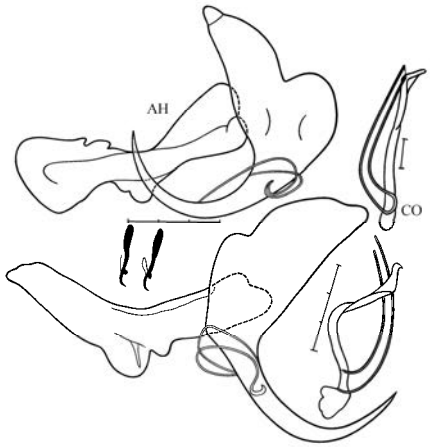
Syn.: *Gyrodactylus cruciatus* Wedl, 1857

These medium or large worms have a body length up to 1.0 mm. Length of marginal hooks is 0.014–0.021 mm. The anchors are of the same shape and size; their total length is 0.045–0.065 mm, bars 0.006–0.010 x 0.035–0.045 mm. Total length of copulatory organ is 0.040–0.050 mm, diameter of tube about 0.003 mm. A vaginal duct and opening are not present.

Found on gill filaments of *Misgurnus fossilis*; perhaps its distribution coincides with host area.



366



367

Fig. 366 – 367.
366 - *Ancyrocephalus (=Ligictaluridus) monticellii* (?) from Tisa River. **367 -** *Ancyrocephalus (=Ligictaluridus) monticellii* from Poland (after Prost, 1973).

24 (23). The anchors are different shapes: the ventral pair has well-developed roots, whereas the dorsal anchors almost lack an outer root. The copulatory tube is undulated.

A. curtus Akhmerov, 1952 (Fig. 370)

These are small or medium size worms; body length can be up to 0.42 mm and width to 0.09 mm. Length of marginal hooks is 0.016–0.020 mm. Total length of ventral anchors is 0.040–0.045 mm, dorsal anchors 0.045–0.049 mm. Ventral bar is 0.004–0.006 x 0.037–0.045 mm, dorsal bar 0.004–0.006 x 0.037–0.044 mm. Length of copulatory tube is 0.030–0.040 mm, diameter about 0.002 mm. Length of accessory piece is 0.020–0.026 mm. Vaginal armament is absent.

Found on gill filaments of *Perccottus glenii*; Amur River and Suifun Basins.

25 (22). The accessory piece of the copulatory tube has long projections that are more or less **X**-shaped.

26 (27). The ventral anchors have a broader main part than the dorsal anchors and have a poorly developed outer root. Vaginal armament is absent.

A. assimilis Gussev, 1955 (Fig. 371)

These worms are minute; body length can be up to 0.23 mm and width to 0.09 mm. Length of marginal hooks is 0.011–0.013 mm. Total length of ventral anchors is 0.018–0.022, dorsal anchors 0.025–0.028 mm. Ventral bar is 0.003–0.004 x 0.024–0.025 mm, dorsal bar 0.003–0.005 x 0.018–0.021 mm. Total length of copulatory organ is 0.028–0.035 mm, diameter of tube 0.002–0.003 mm. Vaginal armament is absent.

Found on gill filaments of *Sarcocheilichthys czerskii*; Lake Khanka (Russia).

27 (26). The main part of the ventral anchors is the same width as that of the dorsal anchors; a well-developed small outer root is present. The vaginal armament consists of two poorly visible bubbles connected by a short tube. These are parasites of *Squalidus chankaensis.*

28 (31). The roots of both pairs of anchors taper to their ends; the length of the outer root is less than 0.003 mm; the length of the ventral anchors is greater than 0.022 and the length of the dorsal anchors is greater than 0.025 mm.

29 (30). Both pairs of anchors have a curved point; the outer root is poorly visible and is less than 0.002 mm; the length of the dorsal anchors is less than 0.035 mm.

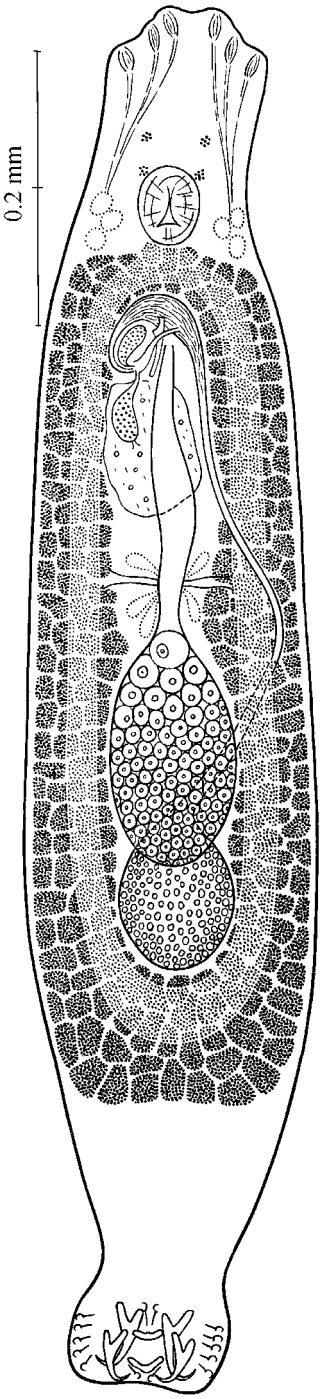
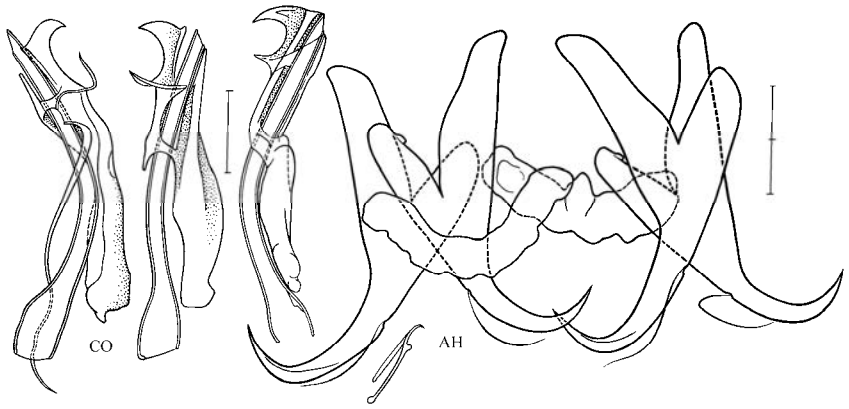
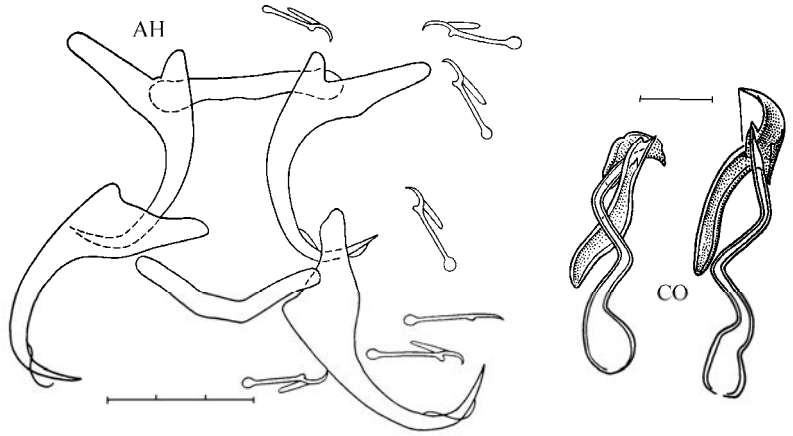


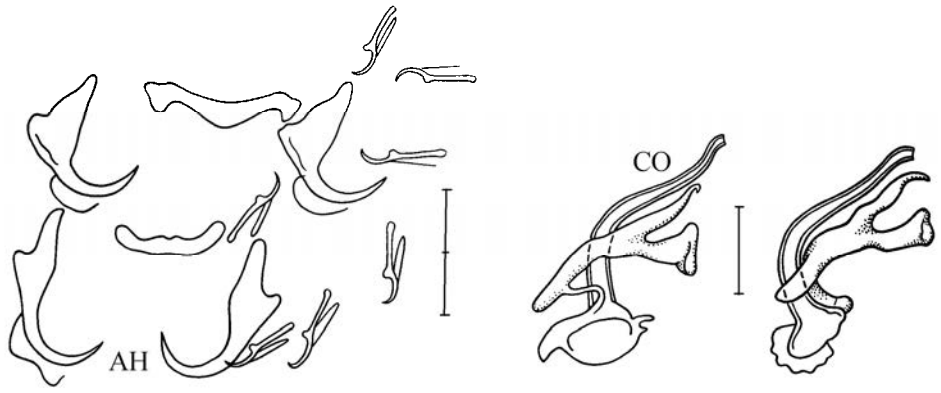
Fig. 368. *Ancyrocephalus cruciatus* (ventral view).



369



370



371

Fig. 369 – 371.
369 - *Ancyrocephalus cruciatus* from Tisa River. **370 -** *Ancyrocephalus curtus* (after Gussev, 1955a). **371 -** *Ancyrocephalus assimilis* (after Gussev, 1955a).

A. polymorphus Gussev, 1955 (Fig. 372)[70]
Syn.: *A. polymorphus* f. typica Gussev, 1955

These small worms have a body length up to 0.35 mm and width to 0.08 mm. Length of marginal hooks is 0.012–0.017 mm. Total length of ventral anchors is 0.023–0.027 mm, dorsal anchors 0.027–0.034 mm. Ventral bar is 0.004 x 0.021–0.023 mm, dorsal bar 0.002–0.004 x 0.021–0.026 mm. Total length of copulatory organ is 0.035–0.050 mm; diameter of tube 0.002–0.003 mm.

Found on gill filaments of ***Squalidus chankaensis***; Lake Khanka (Russia).

30 (29). The point of the dorsal anchors is opened and the length of the dorsal anchors is greater than 0.035 mm; the outer root of both pairs of anchors is about 0.003 mm.
A. kamegaii Gussev, 1985 (Fig. 373)
Syn.: *A. polymorphus* f. "A" Gussev, 1955

These are small worms; body length can be up to 0.3 mm and width to 0.07 mm. Length of marginal hooks is 0.013–0.016 mm. Total length of ventral anchors is 0.025–0.031 mm, dorsal anchors 0.036–0.043 mm. Ventral bar is 0.003 x 0.023–0.025 mm, dorsal bar 0.004 x 0.022–0.025 mm. Total length of copulatory organ is 0.035–0.038 mm.

Found on gill filaments of ***Squalidus chankaensis***; Lake Khanka (Russia).

31 (28). The roots of the dorsal anchors are cylindrical with parallel margins; the length of the outer root is greater than 0.004 mm; the length of the ventral anchors is less than 0.022 mm and the length of the dorsal anchors is less than 0.025 mm.

32 (33). The roots of the ventral anchors taper to their ends. The length of the copulatory organ is less than 0.030 mm.
A. ogawai Gussev, 1985 (Fig. 374)
Syn.: *A. polymorphus* f. "B" Gussev, 1955

These are small worms; body length can be up to 0.35 mm and width to 0.08 mm. Length of marginal hooks is 0.013–0.016 mm. Total length of ventral anchors is 0.018–0.020 mm, dorsal anchors 0.019–0.023 mm. Ventral bar is 0.003–0.004 x 0.019–0.021 mm, dorsal bar 0.003 x 0.021–0.022 mm. Total length of copulatory organ is 0.027–0.029 mm.

Found on gill filaments of ***Squalidus chankaensis***, Lake Khanka (Russia).

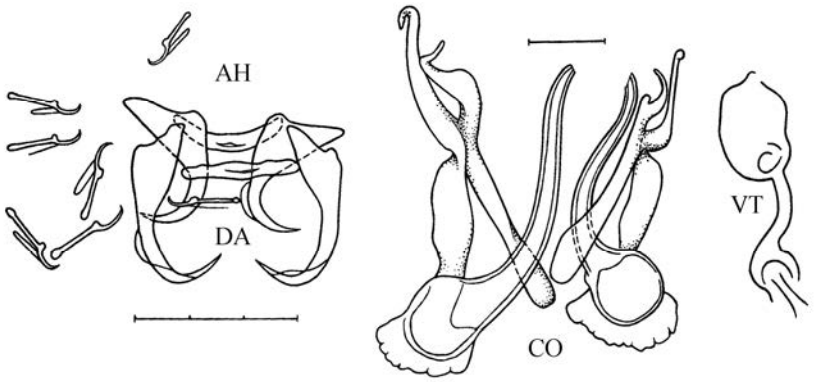
33 (32). The roots of the ventral and dorsal anchors have parallel margins. The length of the copulatory organ is greater than 0.040 mm.
A. hoffmani Gussev, 1985 (Fig. 375)
Syn.: *A. polymorphus* f. "C," Gussev, 1955

These are small worms; body length can be up to 0.35 mm and width to 0.08 mm. Length of marginal hooks is 0.014–0.016 mm. Length of ventral anchors is 0.015–0.021 mm, dorsal anchors 0.015v0.021 mm. Ventral bar is 0.003 x 0.020—0.025 mm, dorsal bar 0.002–0.003 x 0.029–0.031 mm. Total length of copulatory organ is 0.045–0.050 mm, copulatory tube 0.037–0.040 mm.

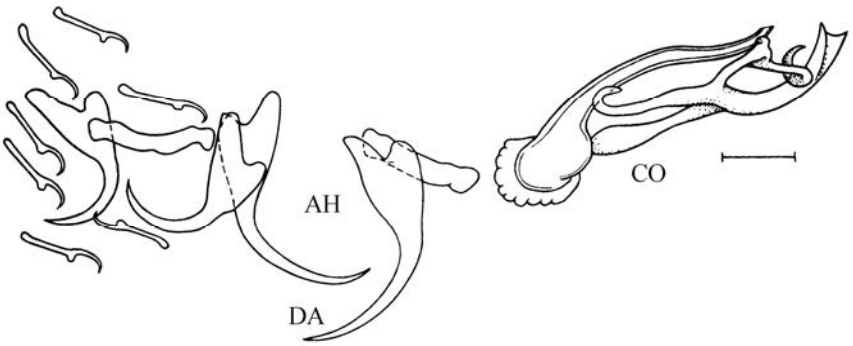
Found on gill filaments of Squalidus chankaensis; Lake Khanka (Russia); Liao He River (China).

34 (15). The blades of the marginal hooks of the I and III–-VII pairs are the same size; a slightly protruded heel and a small broadened handle are present; hooks of the II pair are very thin and poorly visible even on crushed specimens; they are not visible on thick slides. The shape of these hooks is very uncommon: their blade is 1.5 times shorter than that of the other pairs, the heel does not protrude, and the pivot lacks a bulge at its end.

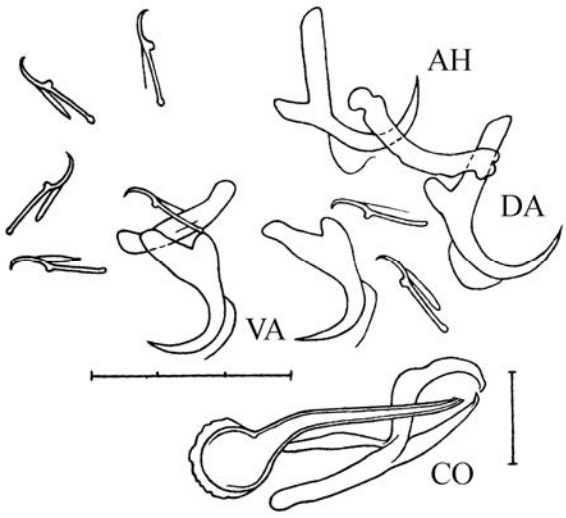
[70] Four forms of this species have been described: typical, "A," "B," and "C". Revision has shown that all of them are independent species (more detailed data can be found in Gussev, 1955a). Types and paratypes are in the monogenean collection of the Zoological Institute RAS (holotypes N 7168, N 7169, N 7170).



372



373



374

Fig. 372-374
372 - *Ancyrocephalus polymorphus.* **373** - *Ancyrocephalus kamegaii.* **374** - *Ancyrocephalus ogawai.*

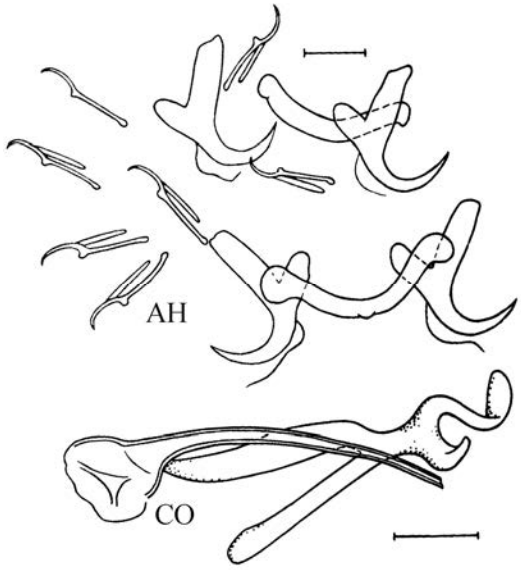
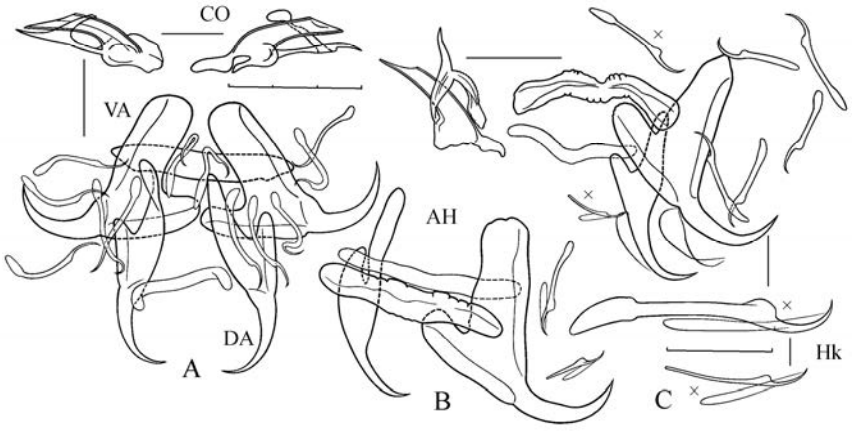


Fig. 375 - *Ancyrocephalus hoffmani.*

35 (36). The ventral anchors are 1.2–1.3 times broader than those of the dorsal anchors.
A. (=Cleidodiscus) brachus Mueller, 1930 (Fig. 376, 377)
Syn.: *Ancyrocephalus parvus* Bauer, 1948; *A. perplexus* Gussev, 1955

376



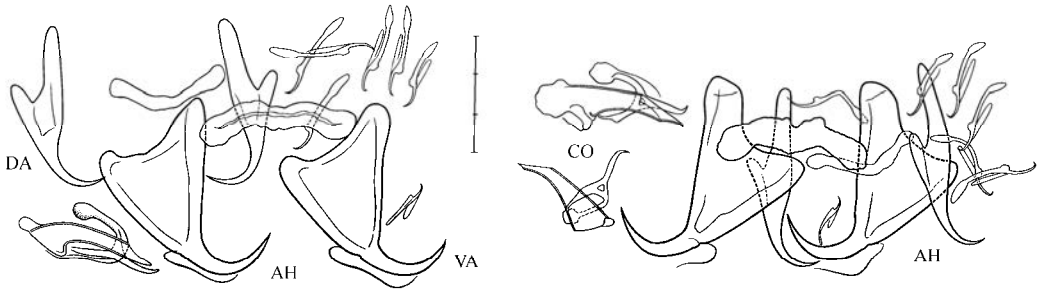
377

Fig. 376 – 377.
376 - *Ancyrocephalus (=Cleidodiscus) brachus* from *Chanodichthys mongolicus,* Lake Khanka (after Gussev, 1955a). **377 -** *Ancyrocephalus (=Cleidodiscus) brachus*: A – from *Phoxinus percnurus*, Yenisei River, B – from *Phoxinus percnurus*, Anadyr River, C – from *Xenocypris macrolepis*, Amur River, symbol «X» marks enlarged drawings of marginal hooks.

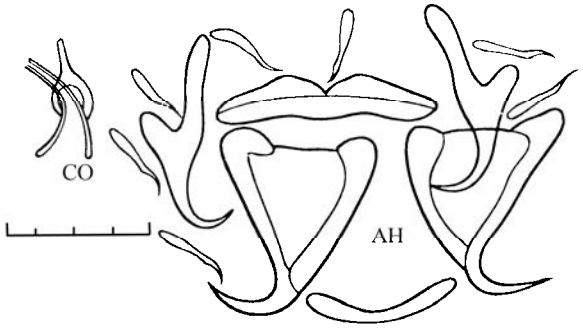
These are large worms; body length can be up to 1.4 mm and width to 0.33 mm. Length of marginal hooks of the I and III–VII pairs is 0.020–0.027 mm, blade 0.005 mm; from the II pair only one hook was poorly visible; its length was 0.013 mm, blade 0.0034 mm. Length of ventral anchors is 1.2–1.3 times broader than the dorsal anchors; total length of ventral anchors is 0.042–0.056 mm, main part 0.029–0.037 mm, inner root 0.019–0.028 mm, outer root 0.008–0.012 mm, point 0.010–0.012 mm. Dorsal anchors are narrow with an open point; length of dorsal anchors is 0.046–0.056 mm, main part 0.025–0.035 mm, inner root 0.018–0.025 mm, outer root 0.007–0.010 mm. Ventral bar is 0.007–0.010 x 0.037–0.047 mm, dorsal bar 0.004–0.008 x 0.038–0.041 mm. Total length of copulatory organ is 0.035–0.041 mm, diameter of tube in the middle 0.004–0.006 mm.

Found on gill filaments of ***Phoxinus percnurus, Chanodichthys mongolicus,*** and ***Xenocypris macrolepis***; Yenisey, Anadyr', and Amur Rivers and Lake Khanka (Russia). It has been described in North America from gills of ***Semotilus atromaculatus*** and ***S. margarita.***

36 (35). The ventral anchors differ from that of ***A. (=Cleidodiscus) brachus*** by being broader in the main part; they are 1.5–1.6 times wider than those of the dorsal anchors.
A. (=Cleidodiscus) sp. Gussev, 1985 (Fig. 378)



378



379

Fig. 378-379
378 - *Ancyrocephalus (=Cleidodiscus)* sp. from *Xenocypris macrolepis,* Amur River. **379 –** *Ancyrocephalus zhejiangensis* (after Wu et Wang, 1982).

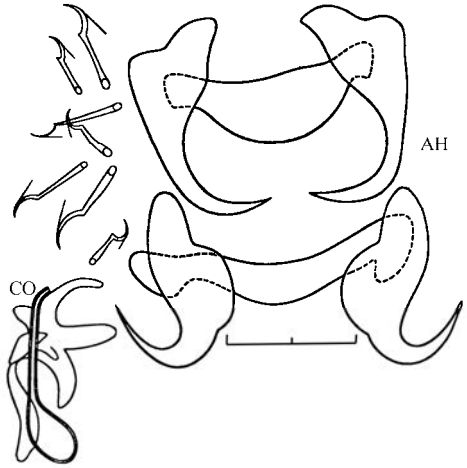


Fig. 380.
380 - *Ancyrocephalus* (s.l.) *hangchowensis* (after Wu Bao-hua, 1963).

These are large worms; body length can be up to 1.2 mm. Length of the I and III–VII pairs of marginal hooks is 0.019–0.028 mm, II pair 0.013–0.015 mm. Length of ventral anchors is 0.043–0.049 mm, main part 0.038–0.040 mm, inner root 0.010–0.015 mm, outer root 0.004–0.005 mm, point 0.010–0.011 mm. Length of dorsal anchors is 0.042–0.049 mm, main part 0.028 mm, inner root 0.017–0.020 mm, outer root 0.004–0.007 mm. Ventral bar is 0.008–0.011 x 0.040–0.043 mm, dorsal bar 0.003–0.005 x 0.030 mm. Total length of copulatory organ is 0.030–0.040 mm, diameter of tube 0.005–0.007 mm.

Found on gill filaments of *Phoxinus* sp. and *Xenocypris macrolepis*; Lake Issyk-Kul' (Kyrgyzstan), Amur River (Russia). A new species (*Ancyrocephalus zhejiangensis* Wu and Wang, 1982) from gill filaments of *Plagiognathops microlepis* has been described, and it is very similar to *A. (=Cleidodiscus)* sp. It differs in the size of the chitinoid structures and slightly by the copulatory organ (Fig. 379). It is a large worm according to the original description; body 1.04–1.74 x 0.32–0.57 mm. Length of marginal hooks is 0.016–0.023 mm; the small hooks of the II pair were not noticed by the authors. Length of ventral anchors is 0.049–0.052 mm, main part 0.034–0.040 mm, inner root 0.016–0.018 mm, outer root 0.009–0.018 mm, point 0.009–0.014 mm. Length of dorsal anchors is 0.045–0.049 mm, main part 0.020–0.027 mm, inner root 0.022–0.025 mm, outer root 0.007–0.012 mm, point 0.005–0.009 mm. Ventral bar is 0.056–0.063 x 0.012–0.016 mm, dorsal bar 0.007–0.011 x 0.043-0.063 mm. Length of copulatory tube is 0.027–0.031 mm, diameter of its initial part 0.011–0.016 mm, middle part 0.002–0.003 mm, accessory piece 0.025–0.026 mm.

Supplement to Ancyrocephalinae

I. *Ancyrocephalus* (s.l.) *hangchowensis* Wu Bao-hua 1963 (Fig. 380) has been described from gill filaments of *Sarcochilichthys sinensis lacustris* from the Yangtze River Basin (China).

These small or medium size worms have a body length that can be up to 0.64 mm and width to 0.09 mm. Length of marginal hooks of the larval type is 0.010–0.015 mm. Length of ventral anchors (outer root is absent) is 0.026–0.028 mm, main part 0.017–0.019 mm, inner root 0.009–0.010 mm, point 0.009–0.011 mm. Length of dorsal anchors is 0.031–0.037 mm, main part 0.025–0.027 mm, inner root 0.007–0.010 mm, outer root 0.004–0.005 mm, point 0.007–0.010 mm. Ventral bar is 0.006–0.009 x 0.030–0.034 mm, dorsal bar 0.011–0.013 (in the middle) up to 0.005–0.006 (at the ends) x 0.025–0.029 mm. Total length of copulatory organ is 0.031–0.041 mm, length of tube 0.027–0.032 mm, diameter in the initial part 0.009 mm, in the middle 0.002–0.003 mm. Vaginal armament is a short tube that makes a loop; its length is 0.010–0.018 mm and diameter 0.001–0.002 mm, and it opens dextrally.

This species is very similar to *A. assimilis* Gussev, 1955 according to the structure of the copulatory organ.

II. Ancyrocephalins from the gills of the American fish *Lepomis gibbosus* (Centrarchidae), which now is widely distributed in the Danube River Basin and other western European rivers, are not included in this Key. Twenty-seven species of ancyrocephalins (in eight genera) have been described in N. America from this small fish. Two species, *Haplocleidus dispar* (Mueller, 1936) (Fig. 381) and *Urocleidus similis* (Mueller, 1936) (Fig. 382), have been found in the Danube River Basin. Two more species, *Actinocleidus oculatus* (Mueller, 1934) and *A. recurvatus* Mizelle and Donahue, 1944 (Fig. 383, 384), have been found in southern France.

III. Twelve ancyrocephalid species have been described in N. America from the gills of big bass (*Micropterus salmoides*; Centrarchidae). Some of them can be found in Europe, as big bass is widespread in fish farms.