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Changeability of Ciliates of the Genus *Apiosoma*

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Abstract. The author distinguishes two types of changeability of ciliates of the genus *Apiosoma:* the individual and interpopulation changeability. In the individual changeability the author discerns changes in the process of individual development and those taking place under the influence of environmental factors. The latter are of immediate adaptational importance under conditions of parasitic existence of *Apiosoma* on the body surface of fishes.

Main attention is given to the interpopulation changeability which is dealt with on the example of three wide-spread species: *A. piscicola*, *A. megamicronucleata* and *A. campanulata*. The first two species are distributed in the territory between the western and eastern border of the U.S.S.R., while *A. campanulata* has been heretofore found in the European part of the U.S.S.R. and in Central Asia.

A. piscicola has been detected on 17 species of fishes (of which 13 were representatives of the family Cyprinidae), but none of these species may be regarded as main host of *A. piscicola*. On the other hand, *A. campanulata* and *A. megamicronucleata* give a clear preference to certain host species: *A. campanulata* most frequently occurs on *Perca fluviatilis*, *A. megamicronucleata* almost exclusively on *Lota lota*.

The studies on the changeability of body dimensions of these species of *Apiosoma* have shown that there is a direct connection between the value of changeability and the degree of specificity with regard to hosts. *A. piscicola* possesses a wide range of changeability, its populations on various fishes greatly differ from one another. *A. campanulata* and *A. megamicronucleata* are much more stable species, their dimensions vary in a small degree. It may be concluded that the quantitity and quality of hosts determine the structure of *Apiosoma* species.

The ciliates of the genus *Apiosoma* (family Scyphidiidae Kahl 1935, *Peritricha Sessilia*) are notable for great changeability of shape of their body and nuclei, which considerably hampers the researchers in identifying the species. This property is pointed out by Lom (1966) and by some other authors. The species of *Apiosoma* occurring on freshwater fishes of the U.S.S.R. have been described by Shulman (1962). In recent years, however, the number of found species has considerably increased.

At present the species composition of *Apiosoma* parasitic on fishes is of great interest to parasitologists, because recent studies confirm the leading role of these ciliates in the formation of parasite fauna of young fishes. In pond fish cultures

death incidence of fishes is sometimes observed due to pathogenic effect of *Apiosoma* (FIJAN 1962, RAZMASHKIN and SKRIPCHENKO 1965).

On one hand the study of changeability of *Apiosoma* species will help solve the tasks of taxonomy, on the other, it may elucidate the role of the host organism for these ciliates because the changeability of *Apiosoma* is closely connected with their living conditions.

While studying the fauna of *Apiosoma* parasitizing the fresh-water fishes of the U.S.S.R., the author of the present paper observed the character and degree of changeability of separate species, confronted these observations with some ecological peculiarities of their existence and drew some conclusions on the character of interrelationship of *Apiosoma* with the fish organism.

MATERIAL AND METHODS

Populations of 10 species of *Apiosoma* collected from 17 species of fishes captured primarily in the water reservoirs of the European part of the U.S.S.R. were examined. Descriptions of these species are given in the author's papers (BANINA 1966, 1968 in litt.).

The present paper deals with the problems of changeability of these ciliates, taking as most typical examples some specimens from the total number studied. These have been examined both alive and in preparations fixed by Schaudinn's fluid and stained by Heidenhain's hematoxylin. To determine the scope of changeability in each population of ciliates, the measurements of 30—50 specimens have been taken and the data obtained have been statistically processed. A preliminary comparison of corresponding body dimensions of ciliates in live and fixed state has shown that a quick fixation by Schaudinn's fluid does not produce a deforming effect on their bodies (BANINA, in litt.). This fact made it possible to take the measurements of fixed preparations.

RESULTS

Individual changeability. Our observations have led to the conclusion that two types of individual changes should be distinguished in the ciliates of the genus *Apiosoma*, the character and causes of these changes being fundamentally different.

1. Changes of the body shape during developmental cycle

These changes are induced by interior physiological causes—differences in dimensions and outer appearance of specimens in various stages of individual development, during the preparation for division etc. In his paper (1966) LOM describes considerable differences in the appearance of *Apiosoma* in various stages of individual development. We have also observed them, but they do not play a primary role in the diverse variations within a population.

2. Changes under the influence of environmental factors

Changes of this type are fundamental and cause the diversity of appearance of the ciliates within a population. The shape of the body of a ciliate of the genus *Apiosoma* can change abruptly under the influence of environmental factors. This capability is developed in them more strongly than in other sessiline peritrichs.

Table 1. Dimensions of *A. piscicola* from different hosts (in μ)

Host species	Number of populations studied	Length			Width		
		$\chi \pm Sx$	maximum	minimum	$\chi \pm Sx$	maximum	minimum
Rutilus rutilus	2	56.0 ± 2.2	72.0	36.0	27.0 ± 1.0	36.0	18.0
Salmo irideus	1	57.6 ± 0.9	73.8	46.8	20.9 ± 0.36	25.2	14.0
Leuciscus idus	1	60.0 ± 1.4	75.6	43.2	18.4 ± 0.4	25.2	12.6
Cyprinus carpio (wild carp)	2	61.0 ± 1.8	86.4	39.6	20.7 ± 0.8	28.8	10.8
Leuciscus leuciscus	1	62.0 ± 1.0	79.2	46.8	19.5 ± 0.32	25.2	14.5
C. carpio (cultured carp)	3	77.0 ± 1.9	93.6	61.2	29.0 ± 1.4	36.0	21.6
L. idus	2	90.0 ± 3.8	129.0	57.2	27.0 ± 2.9	54.0	18.0
Scope of variations		34.6	57.0	25.2	9.3	28.8	7.2

A distinctive peculiarity of *Apiosoma* is also the fact that the change of the body shape is accompanied by adequate change of the shape of macronucleus. This phenomenon can be observed in the ciliates of the species *A. shulmani* Kashkowskii and *A. cylindriformis* Chen, which are depicted in Fig. 1.

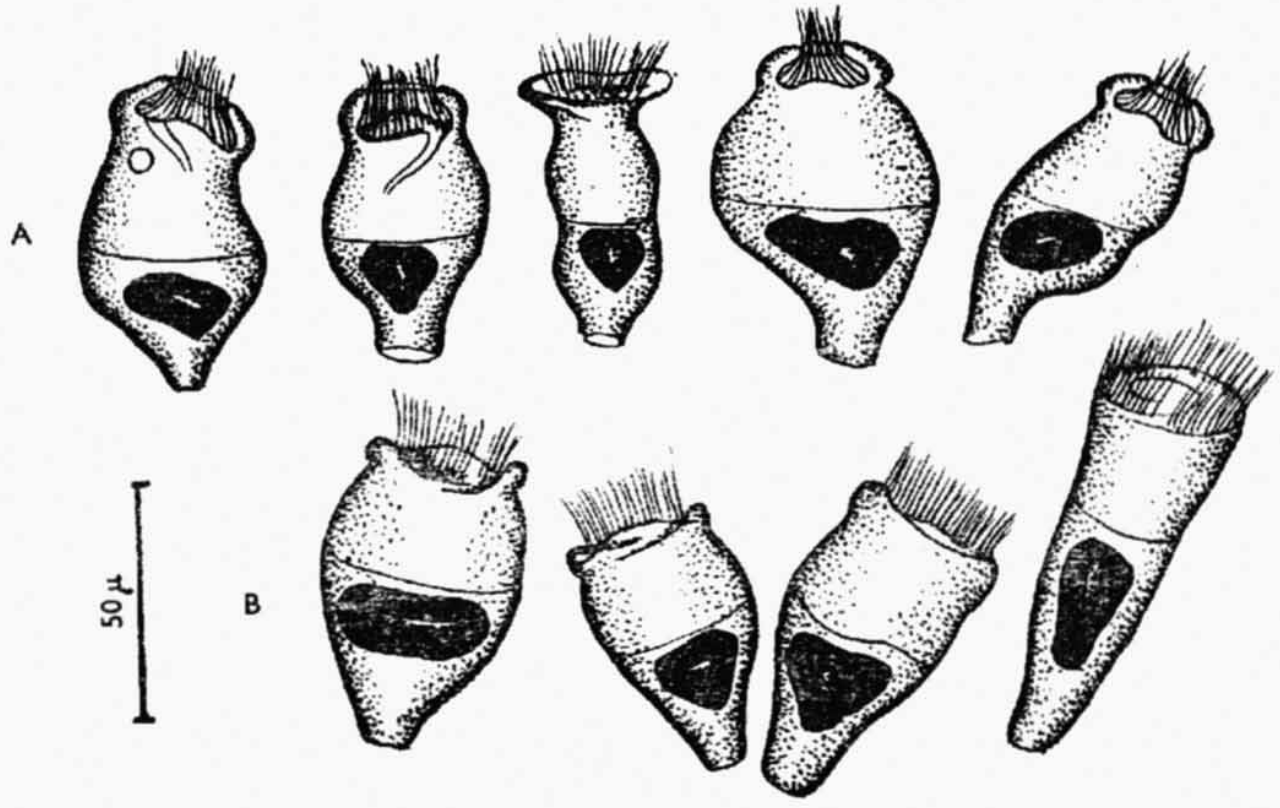

Fig. 1. *A. shulmani* (A), *A. cylindriformis* (B). Variations of body shape inside populations collected from one host.

The capability to change the shape of body and of macronucleus becomes especially evident in cases of a heavy invasion, when the ciliates are packed closely one to another. Due to the fact that the mutual pressing does not cause any harm to specimens capable to adjust their body shape to the character of space available

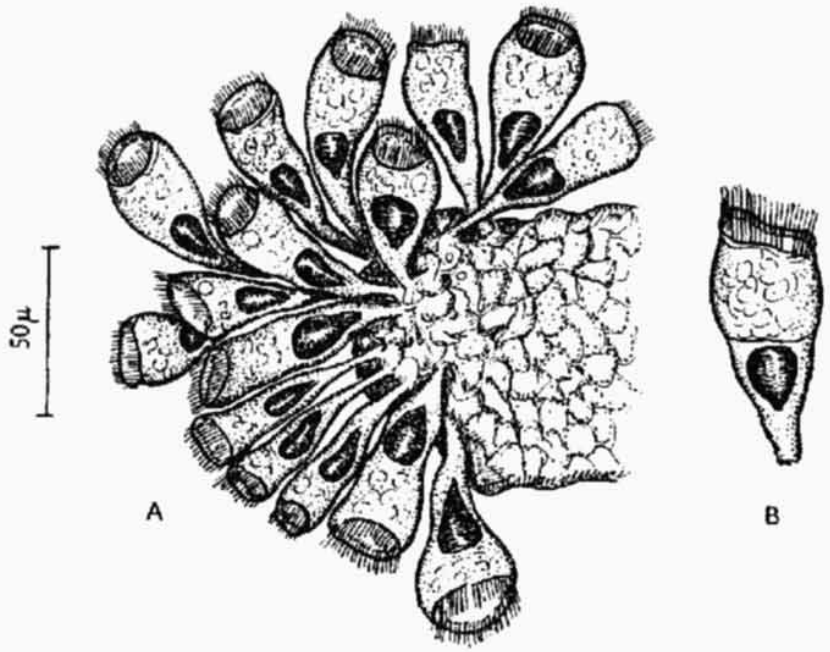

Fig. 2. *A. cryptomicronucleata* on gill filament of *Gasterosteus aculeatus*. A — example of heavy invasion, B — single specimen in a free attachment.

to them, the ciliates can exist under very cramped conditions and make a full use of the body surface of the host. A typical cramped distribution of ciliates is shown in Fig. 2, depicting a case of heavy invasion of *Apiosoma cryptomicronucleata* sp.n. on the gills of *Gasterosteus aculeatus*.

Table 2. Dimensions of *A. campanulata* from different hosts (in μ)

Host species	Length			Width		
	$\chi + Sx$	maximum	minimum	$\chi \pm Sx$	maximum	minimum
Perca fluviatilis (from various water reservoirs)	43.9 ± 0.7	54.0	32.4	19.8 ± 0.4	24.1	12.6
	43.0 ± 0.7	54.0	32.4	22.3 ± 0.4	28.8	14.5
	40.7 ± 0.9	48.6	30.6	18.7 ± 0.4	23.4	14.4
	40.0 ± 1.0	43.2	28.8	18.5 ± 0.7	25.6	12.6
	38.8 ± 0.6	57.6	28.8	21.2 ± 0.4	25.2	14.4
Aserina cernua	39.2 ± 0.9	57.7	25.2	23.7 ± 0.5	32.0	16.2
	39.0 ± 1.2	54.0	25.2	18.2 ± 0.4	21.6	14.4
	38.9 ± 0.7	57.0	28.8	16.6 ± 0.4	19.8	12.6
Esox lucius	40.0 ± 0.8	61.2	21.6	22.0 ± 0.8	29.0	14.4
	34.2 ± 0.7	46.8	25.8	17.6 ± 0.5	25.2	12.6
Scope of variations	9.7	18.0	10.8	7.1	12.2	3.6

Table 3. Dimensions of *A. megamicronucleata* (in μ)

Host species	Length			Width		
	$\chi \pm Sx$	maximum	minimum	$\chi \pm Sx$	maximum	minimum
Lota lota (from different water reservoirs)	43.6 ± 1.1	61.2	28.8	30.6 ± 0.5	37.8	21.6
	41.8 ± 0.6	46.8	32.4	24.8 ± 0.4	28.8	14.4
	39.6 ± 0.7	50.6	28.8	29.2 ± 0.5	36.0	21.4
	39.6 ± 0.7	56.2	28.8	29.7 ± 0.6	39.6	23.4
	37.1 ± 0.6	46.8	28.8	26.8 ± 0.5	36.1	19.8
Esox lucius	44.0 ± 1.0	61.2	32.4	24.2 ± 0.5	36.0	21.7
Scope of variations	6.9	14.4	3.6	6.4	11.2	9.0

Interpopulation changeability. The changeability of this type is caused by the differences among populations within one species. The ciliate populations collected from various specimens of fishes may differ both in morphological peculiarities and dimensions. As a rule, the morphological peculiarities are observed in the body shape of ciliates and to a lesser degree in the nuclear apparatus. Only in separate populations of some species, characterized by the inconstancy of mutual arrangement of macro- and micronucleus (*Apiosoma amoebae* Grenfell, *Apiosoma baueri* Kashkowskii), one position of micronucleus predominates. The characteristic peculiarities usually become apparent in most specimens of the population and impart to it a qualitative originality. At present it is difficult to say whether this form of changeability of ciliates is strictly genetically conditioned or whether it is a phenotypic phenomenon.

The most apparent interpopulation differences are peculiar to *Apiosoma piscicola* Blanchard. The specimens of this species from different populations differ from each other primarily in dimensions, then in the body shape and the length of the basal part of the body (Fig. 3).

However, the interpopulation changeability has not been observed in all species of ciliates in equal degree. Moreover, in two other species studied from this aspect—*Apiosoma campanulata* Timofeew and *Apiosoma megamicronucleata* Timofeew—a contrary phenomenon has been observed. With *A. campanulata* the dimensions vary within stable limits, which are rather similar in various populations. The same picture of relative stability of dimensions is observed with *A. megamicronucleata*. No marked morphological differences are observed even among populations within the species *A. campanulata* and *A. megamicronucleata* from different hosts and therefore we present in this paper the illustration of typical forms of both species (Fig. 4).

A. piscicola and *A. megamicronucleata* are most widespread of all ciliates found in the territory of the U.S.S.R. at present (more than 20 species). The two species occur between the western and eastern border of the country both in its European part and in Siberia. *A. piscicola* has been also found in Central Asia. *A. campanulata*

has been detected in a number of localities in the territory of the European part of the U.S.S.R. and in Central Asia.

As for the host composition, there are about 17 host species of *A. piscicola* in the territory of the U.S.S.R. alone and there is a good reason to suppose that their range will be further extended.

The number of hosts of *A. campanula* is rather high, but *Perca fluviatilis*, with which this ciliate is most closely associated (Fig. 2), is the predominant species among them. *A. megamicronucleata* is closely associated with a certain host species. In

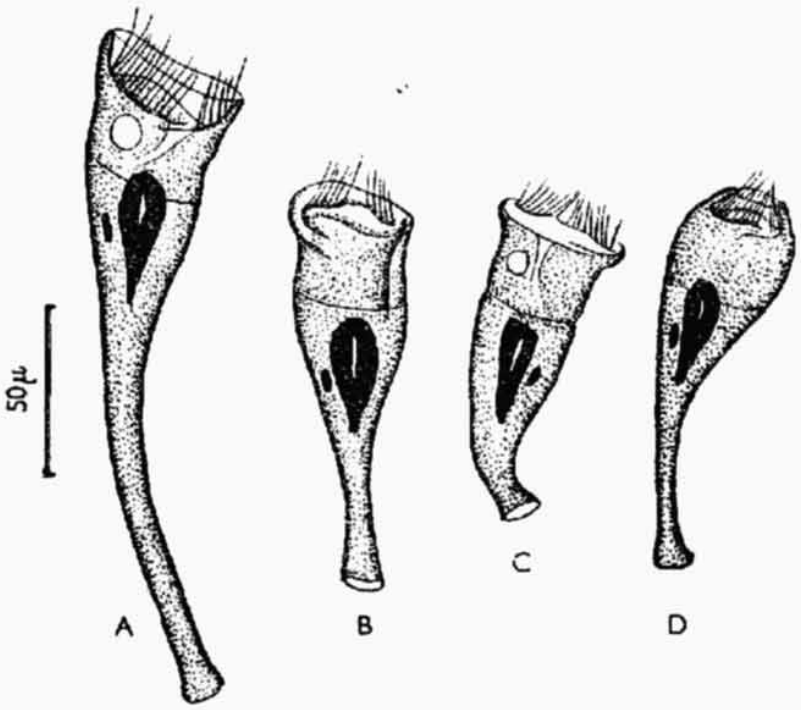

Fig. 3. *A. piscicola.* Typical specimens of populations collected from different hosts: A — from *Leuciscus idus*, B — from *Rutilus rutilus*, C — from *Salmo irideus*, D — from *Cyprinus carpio.*

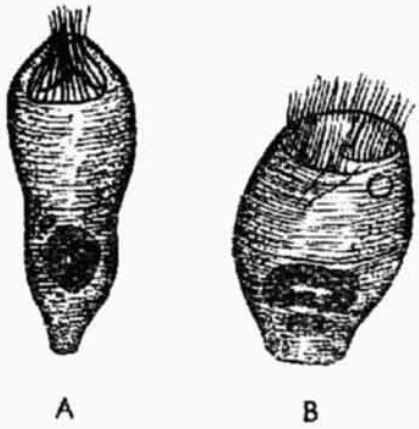

Fig. 4. *A. campanulata* (A), *A. megamicronucleata* (B).

the whole territory of the U.S.S.R. it occurs almost exclusively on *Lota lota*. Its finding on *Esox lucius* must be considered as accidental, because it happened in the same water reservoir where *A. megamicronucleata* has been found on *L. lota*.

If the degree of intraspecific changeability of three widespread species is compared with the ecological peculiarities of their habitation, certain conclusions may be drawn. *A. piscicola* possesses a wide distribution area, parasitizes many fishes without giving preference to any particular fish. The range of diverse conditions under which this species is living is relatively wide. We presume, that the strong intraspecific changeability observed with this species on one hand has resulted from the diversity of its living conditions and on the other, is in itself a property facilitating the adaptational reaction of the species to that diversity.

The population differencies with the two other species *A. campunulata* and *A. megamicronucleata* are rather small, despite their wide distribution areas. They have strongly marked specific features and clearly stand out among all other known *Apiosoma*. It may be presumed that their host specificity may be considered as the main circumstance of this peculiarity. Their association with a certain fish species

becomes evident in their ecology, especially with *A. megamicronucleata*. Due to this fact, more stable living conditions for the species are created and the necessary or possible intraspecific changeability is restricted.

CONCLUSION

While summing up the material studied, some words should be added about the role of changeability in the ecology of ciliates.

The changes of the body shape during the developmental process are induced by physiological causes (stage of development, preparation to division etc.) and are of no direct adaptational importance for the life of ciliates on the fish body.

The increased capability of changing the body shape under the influence of external factors, in our opinion, is a peculiar adaptation of ciliates to the parasitic way of life, in particular to the utilization of living space on the host's body.

The interpopulation changeability of ciliates reveals a close relation with the number of hosts which the given species parasitizes. The more diverse the range of hosts, the wider the scope of changeability of its parasites.

This dependence confirms the leading role of the fish organism as the most important factor in the ecology of *Apiosoma* determining the specific structure of these ciliates.

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