STUDIES ON DETRITUS DRIFTS IN LAKE BALATON*

BY

OLGA SEBESTYÉN

From the Hungarian Biological Research Institute, Tihany, Lake Balaton

(Received for publication 10th March, 1949.)

Results of previous investigations of the drifts on the shore of Lake Balaton (ENTZ, SEBESTYÉN and SZABÓ, 1942) suggested that a thorough study of drifts built of detritus might help to elucidate the problem of organic detritus, including its rôle and significance in the cycle of organic substances within our lake.

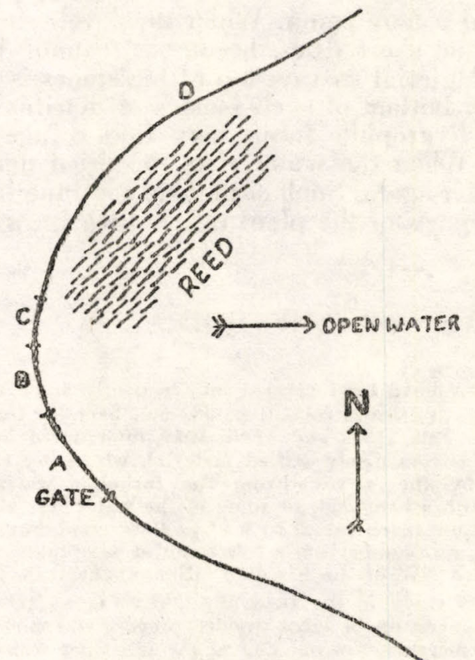

Figure 1. A sketch of Kis-öböl bay, Tihany, Lake Balaton showing localities of collections (section „A"—„D").

* A report of this paper was read before the Xth International Congress of Limnology, Zürich, August, 1948. A brief summary will be published in the Proceedings of the I A L.

In the course of field observations covering several years it could be established that on certain sections of the shores of the Tihany peninsula, detritus was cast ashore frequently and in abundance. A section of the W shores is specially subjected to the accumulation of detritus (see ENTZ, SEBESTYÉN and SZABÓ, 1942, Plate I. Fig. 4). On the E shores of Kis-öböl, a bay located in the neighbourhood of the Biological Institute, is known for this. The shores of this bay were therefore chosen for the present studies (Fig. 1).

The main road running along the shores is protected from the waves in the bay by a stone wall and loose quarried stones (SEBESTYÉN, 1948 p. 104). A section of the SW part of the shores of the bay — about 15 m long (section „A", Fig: 1.) — located between a small reed growth and the gate of the Institute altogether 36 m in length (sections „A"—„C") is a typical place where detritus drifts are frequent. Along this 15 m stretch detritus accumulates in great masses and, depending on the water level and wave action, it forms either a dark sediment belt of 2—3 m in width resembling „f ö r n a" (SERNANDER), the particles may be dispersed in the turbulent water, lending a dark brown color to it, or — at least part of it — is cast ashore. Sooner or later this material washes into the water again, floating for a while before sinking. When conditions allow, it is washed ashore again. When the level sinks gradually, the detritus mass left on shore dries, because it cannot be reached by the waves any more. Material cast on top of big stones is especially exposed to that fate. At the bottom of such masses of detritus in the favourable season, terrestrial hygrophile forms may find refuge (ETNZ, SEBESTYÈN and SZABÓ p. 35). When the water rises the dried detritus comes under the rule of the water again. Such situations continue for years. This may be the reason that parts of the plant debris turn brown and have a turf-like appearance.

METHOD

Field observations have been carried on frequently since 1930 on the shores of Kis-öböl (ENTZ, SEBESTYÉN and SZABÓ p. 53—60). Samples for quantitative analysis were collected between June, 1942 and April, 1944, interrupted by the winter. Most of the samples were taken from newly drifted material, which lay close to the water and was being sprinkled by the waves. From the turbulent water the floating detritus particles were taken with a hand-net, or some of the water was simply drawn up. From the bottom of the shallow reach the „f ö r n a" like sediment was brought up by means of a hand-net or a jar. For comparison a few samples were taken from the Aszófői-öböl, an extensive bay located NW of the Kis-öböl. (SEBESTYÉN 1948, p. 100).

Following a brief study in the field, the desired material, viz. 50—100 cm^3 from the detritus drift, was taken up in large wooden pincers and carried in a porcelain cup to the laboratory. The measuring of one cm^3 of the substance was done as follows: using small metal pincers, particles of the samples were placed with care in a measuring-cylinder of 10 cm^3 volume, which held about 4 cm^3 lake water, filtered twice, till the contents of the cylinder increased by one cm^3. This was then poured out into a watch glass. For microscopic investigation a binocular preparatory microscope was used (Oc. V, Obj. 40). All the elements which could be recognised with the lens power mentioned, were noted, except those of plant debris. Qualitative studies were made in a similar way, without measuring the volume or enumerating the elements. The material was always studied in a wet condition, so as to find the animal constituents alive. It was no use measuring the weight considering that the amount of water adhering to minute objects such as an ephippium or a lower crustacean, etc., would outweight the object itself.

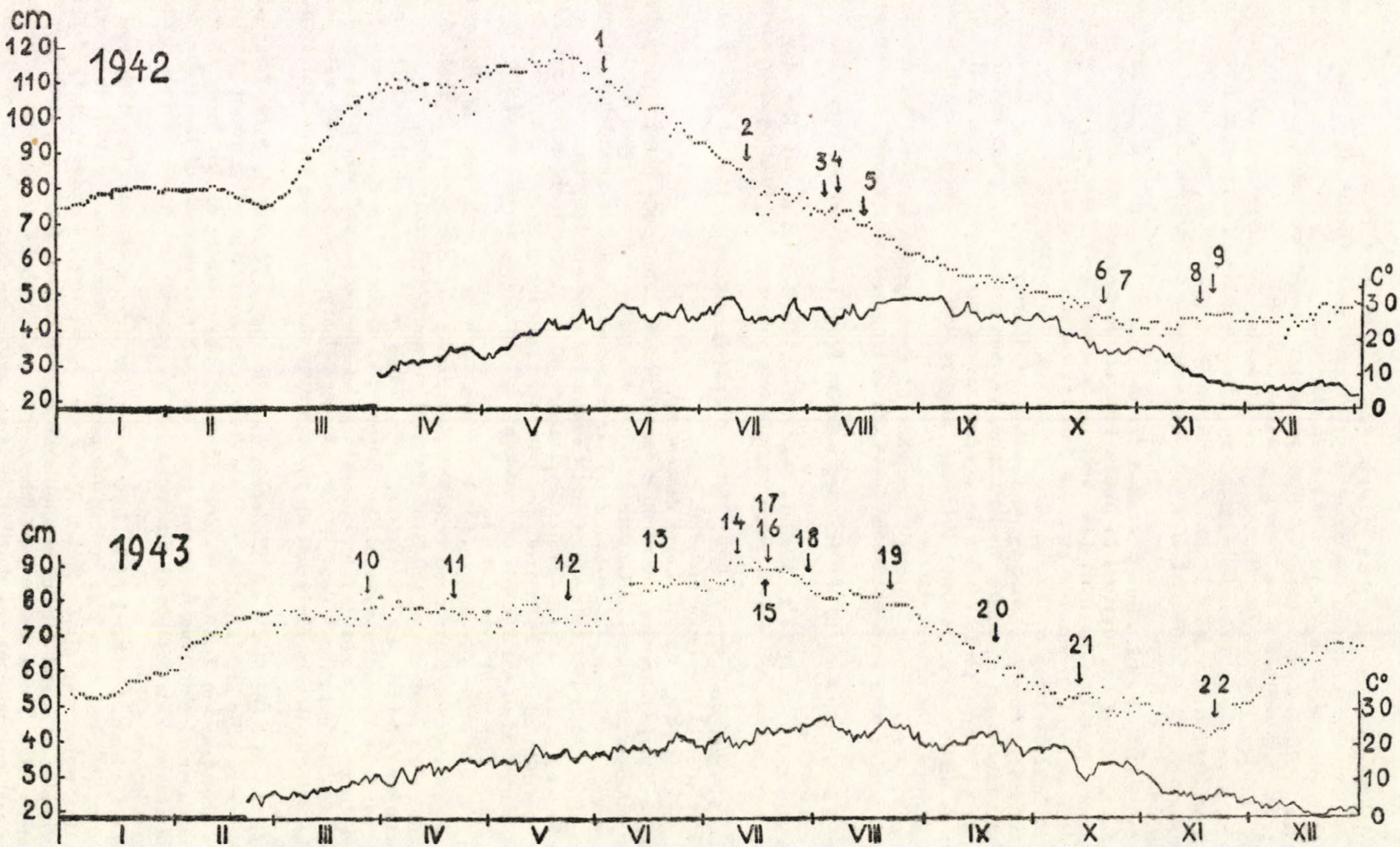

Figure 2—2. Level (............) and temperature (————) of lake water, Tihany, 1942. and 1943.

THE SAMPLES.

All the samples except Nos 16ab and 17ab were collected in Kis-öböl bay. If not indicated otherwise the samples are from detritus drifts. (q = qualitative analysis; Q = quantitative analysis; F = floating detritus).

June 4th, 1942. Unusually high water for about two months. Level now descending. Stormy weather a few days previously. NE wind.

No. 1. (q). Few pelagic species present among the plant debris (*Ceratium hirundinella*, *Keratella cochlearis*, *Conochilus* sp., alive; *Melosira*, *Pediastrum*, *Keratella*, dead). A few *Bangia* filaments originate from the rich growth of algae attached to stones in the vicinity. A statoblast of *Lophopus*, a species not known hitherto in the lake, is found.

July 14th, 1942. Stormy weather for days strengthening to a gale at night and continuing during the previous 24 hours. Part of the detritus still afloat.

No. 2. (q + Q). The drift („A" section) is about 2—3 days old, but washed constantly in and out. It consists of green and brown, that is newly broken and old particles of macrovegetation; *Cladophora glomerata* filaments, partly empty cells. *Epistylis* colonies, empty gemmules and shells of Ostracods frequent. Tardigarda (*Macrobiotus macronyx*) noted for the first time. Various animal and plant constituents.

August 6th, 1942. Drifts everywhere along the shores (Sects. A B C D). The previous night a heavy shower (16 mm). Raining. Off „A" section there is much floating detritus in the water (see No 3a).

No. 3. („A" section) (q + Q). Branches of *Potamogeton* beneath the detritus drift, which mingle with reed fragments 6—14 cm in length. Fewer animal constituents than in No. 2.

No 3a (F, q). Most of the fragments derive from insect larvae, very likely of *Cryptochironomus* sp.

August 10th, 1942. Medium water level. Drift formed on the day of collection, wave action had ceased when sample was taken. Much floating detritus in the water.

No. 4. (Section „B") (q + Q). Habit of drift is similar to that of Nos 2 and 3, very likely it is of the same material.

August 17th, 1942. Level descending.

No. 5. (q + Q). Fragments of most varied origin, Arthropods being represented mostly by ephippia and shells of Cladocera. When collection was made from the bottom of the open water off shore, fragments of similar origin were noted in abundance. Among the live constituents wheel animacules and chironomid eggs are frequent.

October 23d, 1942. Water-level about 30 cm lower than during previous collection, portions of the bottom of the bay emerged above water. Drift scarcely developed, consisting of sand, shells of *Dreissena*, *Lithoglyphus*, as well as of the fallen leaves of trees. The plant debris is brown.

No. 6. (q + Q). Filaments of *Cladophora* — with a rich coat of *Diatoma vulgare* — partly dying, from some cells swarmers broke out. *Spirogyra* frequent. Most of the plant debris made up of the most resistant elements in plant tissue.

October 24th, 1942. (Section „D"). Close to the edge of the water powdery fine particles a continuation of the „förna" like sediment in the shallow water. This latter forms a belt about 2 m wide along the shores, beyond which the muddy bottom appears in a lighter colour. Here and there floating detritus. Quiet water, no waves. The detritus is very likely left on the shore by the descending water (not a true drift in s. s.).

No. 7. (q + Q). Shells of Cladocera, mostly badly damaged, very frequent, unsuitable for specific identification. Other chitinous fragments listed in group „Arthropoda" are abundant too. *Diatoma vulgare* frequent. The presence of this form, as well as the abundance of chitinous fragments seems to mark the approach of the end of the favourable season. This sample is distinguished by having the most various living animal constituents (21!).

November 19th, 1942. Low water for over a month. The 17th was a a windy day, followed by a gale lasting for another 24 hours. On the 19th there was no wind, the water was almost quiet. Along the shores (incl. section A, B, C) fallen leaves of poplar trees and detritus accumulated in huge masses, forming a steep barrier at the water's edge. There are sections where only mollusc shells (*Dreissena*, *Lithoglyphus*) are cast out without any detritus. It is an instructive demonstration of the rôle of various factors in the formation of drifts. Here and there detritus dispersed in the water.

N o 8 a (off section „C"; Bottom sediment; q). Structure of material shows its origin, which is the coating („Aufwuchs", RUTTNER) from water plants and submerged stones, detached and tossed about by the waves. Inorganic particles and Diatoms still adhere to each other. Very few live constituents, mostly infusoria, a few *Alona affinis with* winter eggs.

N o . 8 b . (Section „B"; q). Drift material taken from near the previous sample. Fragments of reed and water plants measuring about 1 cm or less, also a few larger pieces of reed and some poplar leaves. Detritus partly old, partly newly broken. It differs from No. 8a, again showing the selective property of the waves. Filamentous algae and Diatoms — alive — more frequent than in No. 8a. Few forms with active motion. Fragments of Cladocera and other Arthropods frequent, but less than in previous month. Water mites and water bears move about slowly, temperature of water 4° C.

N o . 8 c. (q). Floating detritus (off shore section „A"). Shells of Ostracods and some flat green mineral substance (muscovite?) of similar size. Shells of glochidium and veliger larvae. Ephippial female of *Alona affinis*. As to living specimens Nematoda (frequent), *Canthocamptus*, a few Ostracods, free ephippia and the larva of *Driessena* (sphaerium phase) are to be mentioned.

N o . 8 d . Drift material from the same section (q + Q). Many groups are represented, live specimens and fragments. Nematods in abundance, some eggs (?) in decaying plant tissues. Among the fragments, shells of Ostracods, veliger larvae and empty cases of Oligochaeta cocoons noted. Many more animal constituents than in No. 8a. Filamentous algae.

N o v e m b e r 2 1 s t, 1 9 4 2. Previous collections only two days earlier. Three samples taken from the shore, about 1—1.5 m from the water's edge.

N o . 9 a . (q). Finely distributed organic particles, inorganic elements missing. No organism with active motion. A few ephippia (*Monospilus*) and some live gemmules. Dead specimen of *Corophium*. *Cladophora* and *Spirogya* alive.

N o . 9 b . (q). Sample taken at a graeter distance (1.5 m) from the water's edge than the previous one. Material similar to No. 9a, with the difference that it contains plant debris of larger size too. No live constituents, a very monotonous sample.

N o . 9 c . (q). Consists only of Nematods and Infusoria in a live condition. The material very likely originating from the coating of various substrata, still bears a resemblance to its typical structure. The abundance of Nematods is evidently due to this. The effect of wave action is shown in the separation of the gemmules into single specimens.

M a r c h 2 9 t h, 1 9 4 3. No collection during winter. Previous days with clear sky and warm weather. Drifts of pebbles and reed decorate the shores. Here and there small patches of detritus gently washed by the waves. In water floating detritus.

N o . 10 . (q + Q). The animal constituents are mostly fragments. With the exception of Nematods (25 live individuals per cm^3) 12 groups are represented by a few living individuals.

N o . 1 0 a (q). From section „A" some water with floating detritus was drawn up. When poured into a glass cylinder, sedimentation soon began. Volume of sediment about 6%. It consists of plant debris containing epidermis particles and the other parts of plant tissues having the highest resistance. The following forms were found alive: Nematods, a few; Flagellate Protozoa and Infusoria, scarce; Diatoms, abundant. Shells of Ostracoda and Cladocera (*Monospilus*), empty gemmules and byssus thread. Green mineral particles mentioned above present. After the sedimentation of formed elements, the water seemed rather opaque, in it a minute organism (a colourless Mastigophora?) was present in great numbers.

A p r i l 2 1 s t, 1 9 4 3. Detritus drifts on the shore washed by the waves. (No. 11). In the water (section „A") floating detritus (No. 11a).

N o . 1 1 . (q + Q). Empty ephippia of *Monospilus* in abundance. Unusually few shells of Ostracoda, which fact was related somewhat to the gentleness of wave action.

N o . 1 1 a (q). A net haul from the shore water. A few living specimens of *Micronecta* noted, fragments of animal origin being the same as in sample No. 11.

Comparing the spring material (Nos. 10, 11) with the ones collected during the previous autumn, not much difference could be established. Empty shells of *Alona* and *Eurycercus* (?) are more corroded than in Nos 9 a b c, while the heavily built shell of *Monospilus* bears no signs of such process. It is known that in this species the resting egg is encased in the entire shell and that „hibernation", takes place in this condition. The specific gravity of such an ephippum with a shell having several layers of chitinous substance, must be high enough, and may resist wave action better than an empty and thin shell of a species with a more advanced form of ephippium.

May 24th, 1943. No. 12. (q + Q). Plenty of *Epistylis* partly inside empty cases of Oligochaeta cocoons and in gemmules. Living animal constituents scarce. Fragment material is made of 21 groups, the highest number found during the course of this study. Chitinous particles and shells of Ostracoda are the most frequent. Specimens of *Macrobiotus* (in mould with eggs) are smaller than the autumn examples.

June 17th, 1943. No. 13 (q). The plant particles are rather coarse. *Epistylis* abundant, some Rotators and ephippia with eggs. Free branches of *Cladophora*. Among the fragments cast skins of Insecta larvae and shells of Ostracoda noted.

July 11th, 1943. No. 14. (q + Q). Water above medium level. The material cast out — only poorly developed drifts — is wet, though it is not freshly washed out by the waves. Mingled with plant debris only a very few animal constituents are present (Rotators, Protoza, gemmules). Composition of fragment material is rather monotonous.

July 19th, 1943. Water is still above the medium level. Volume of material cast out during the last two weeks amounts to almost nothing. At the time of collection a gentle wave action. At section „A" floating detritus in abundance. Part of the formed material collected from the neighbourhood of the reed growth in the bay (see No. 15 b) differs from this, both in structure and colour. The one originating from the reed is lighter in colour and has a fibrous structure.

No. 15a (q). Newly fragmented green particles of plants mingled with the old, brown material. Epistylis and other Infusors found alive. Fragments of Arthropoda, empty gemmules, etc., present.

No. 15b (q + Q). Its general aspect is similar to No. 15a. More green elements than in No. 15 a. Among the plant debris of usual size very fine particles are also present, which sink very slowly. Epistylis colonies with no more than 32 individuals are attached, mostly to plant debris. Of animal constituents only very few individuals are present. Among the fragments, cast skins of chironomids (larvae and pupae) in abundance. Some fish scales and a dead young fish.

July 20th, 1943. The Aszófői-öböl bay, where these four samples (Nos. 16 a b, 17 a b) were taken, is much larger than Kis-öböl, from which most of the samples originate. Two samples were taken on the shore (Nos. 16 b and 17 b), one immediately at the water's edge (No. 16 a) and the other (17 b) somewhat further. Two hauls were brought up, one being sediment (No. 16 a), the other floating detritus (17 a).

No. 16b. (q). Old plant debris with very finely distributed particles. Hypotricha Ciliata, Nematoda and *Spirogyra* — all alive — in abundance. Cast skins of chironomids (*Cryptochironomus*, and *Protenthes*) dominating among the fragments, the very resistant prothoracal horns of the pupa found separately. Shells of Cladocera (*Acroperus*?) abundant.

No. 17b. (q). The outwashed material is not reached by the waves. Many inorganic constituents, old plant debris, some filamentous algae, pollen of Coniferae were noted. Nematoda only representing the animal constituents.

No. 16a (q). A net haul taken from the water in the close neighbourhood of No. 16 b. It consists of the most resistant parts of plant tissues. *Spirogyra*, Nematoda, Rotatoria, various forms of Infusoria (incl. *Epistylis*) and *Dreissena* were found alive. Fragments are the same as in No. 16 b, with the addition of some dead *Corophium* and fragments of cocoon shells.

No. 17a. There is a wide, dark brown movable layer of detritus above the inorganic sediment of pale grey colour. It is made up of newly broken and old particles. Both animal and plant constituents — alive — are lacking. Fragments of Arthropoda in abundance.

July 31, 1943. Water level descending. Since the previous day, with a heavy storm, a great mass of detritus floats in the shore water, with some finely distributed particles. Material washed out on the shores, and a „förna" like sediment on the bottom.

No. 18 (q + Q). Section „A". The drift material, brown in colour, is made up of plant debris, including the tiny branches of moss, of a turfy appearance. Newly broken particles less frequent. With the exception of *Epistylis* and eggs of unknown origin the groups are represented by few individuals. Branches of *Cladophora* and other filamentous algae — not identified — are scarce. All the gemmules are those of *Spongilla fragilis*. Forming a pavement layer, the group is divided into halves along the equator of the gemmules.

August 23d, 1943. No. 19. Detritus drift (section „A") made of the usual turfy material. (q + Q). Few living organisms present, among them *Spirogyra* (scarce) and *Epistylis* (in abundance). Shells of Ostracoda, of veliger larvae, and chitinous fragments are more varied than the living constituents, resembling No. 18.

S e p t e m b e r 2 3 d, 1 9 4 3. The water level is rising. During this month the shore was decorated with detritus drifts only at section „A". Rainy weather. A neuston formation made up of chitinous fragments, mostly of Cladocera.

N o . 2 0 . (q + Q). Plant debris in a turfy condition. *Cladophora* and *Spirogyra* alive. Animals with active motion but few. (*Epistylis* and other Infusoria), shells of Ostracoda, Cladocera and skins of Arthropoda being the most frequent among the fragments.

O c t o b e r 1 6 t h, 1 9 4 3. Water level low for three weeks. Temperature sinks. The weather is windy and rainy. Much detritus lies on the shore (Section „A") and because of the descending level could not be washed into the lake again by waves of medium strength. The drift forms a band-like barrier on the shore, built up of horizontal sections. The material is arranged in such a manner that the parts furthest from the water's edge consist of the coarsest particles, while those immediately at the water's edge, are made up of finely distributed debris. From such an arrangement the gradually decreasing power of the wave action might be concluded. The shore water is full of floating detritus. An unusually large mass of detritus gathered in this section, in consequence of the stormy season.

N o . 2 1 (q + Q). Among the living constituents the water flea *Iliocryptus* is to be noted especially, it is abundantly present (23 ind./cm^3) alive and nearly as many dead or empty skins). A few living *Monospilus*, ephippia of the same in abundance, but empty shells prevail. Fragments of Arthropoda (incl. insect larvae) very numerous. A year ago *Macrobiotus* was a very frequent constituent of the drifts, while this year since May no specimens have been found till now. The sample is rich in both living and dead constituents.

N o v e m b e r 2 4 t h, 1 9 4 3. Having reached the minimum level about two weeks ago, the water is rising again but it has not yet attained medium level. Drifts on shore, the one (Section „A") built of coarser material, while those near the reed-growth are of finer particles; this selection again is connected with the degree of wave action.

N o . 2 2 . (Section „A", q — Q). Mostly plant debris, including very fine particles too. *Diatoma vulgare*, abundant, *Cladophora*, partly with epiphytes (*Diatoma vulgare*). With the exception of *Epistylis* there are very few animals present. One example of *Aelosoma*, badly damaged, but it moves about. Shell of Ostracoda relatively few. The groups represented by fragments outnumber those representing the living constituents.

N o . 2 2 a (q). Material from the close of the reed growth is made of finer particles with some fibrous structure (epidermis of reed stalk). Elements noted: Nematoda and Diatoms, in abundance, showing that it originated from the coating of various substrata *(Potamogeton pectinatus* in the neighbourhood, its coating consisting of the same constituents).

A p r i l 2 4 t h, 1 9 4 3. N o . 2 3 . A high water level. The submerged stones at the water's edge have no coating. A few shells of Unionidae and of *Lithoglyphus* lay on shore. Detritus cast on shore scarce, this being only on top of large rocks (boulders) where it could not be reached by the waves. The surface of such layers is dry, they are wet underneath. The material has a felt-like structure, a brown colour, being built up of elements found regularly in the drifts. *Cladophora*, a few colonies of Cyanophyceae and Nematoda represent the living constituents. The dead material (fragments) much less monotonous.

RESULT OF THE ANALYSIS

Plant constituents

As to volume, most of the material is of plant origin: bits of reed and submerged aquatic plants *(Potamogeton perfoliatus, Myriophyllum spicatum,* etc.), all growing in the bay. In a systematical sense there is not much variety in the origin of the plant debris, but it differs decidedly according to age. Particles newly broken off could be recognised by the colour, etc., and in such cases even specific identification might be possible. Among the older fragments, however, no more could be established — with the lens power used — than perhaps a distinction of reed from other water plants (Hung. „h i n á r"). Fresh reed debris could be recognised by its fibrous structure too. The old particles, fragments of higher vegetation, moss leaves, minute plants *(Lemna)* turn to a brown somewhat resembling turf in appearance.

Among the fragments of higher vegetation — in a low percentage — other plant organisms of lower systematical standing are mingled, such as moss, fungi and algae. Among the algae filamentous forms are frequent: Cyanophyceae, *Cladophora glomerata, Spirogyra* occasionally *Bangia. Cladophora* is present in almost every sample. It grows abundantly, attached to stones throughout the year, while the appearance of *Bangia* depends on high water level and protracted stormy weather. (ENTZ, SEBESTYÉN, 1946, p. 297). The cells of the *Cladophora* filaments were partly living, partly empty. Besides these species other forms of filamentous habit were found, but with the exception of *Spirogyra* a form of frequent occurrence, no identification could be made. Pediastrum is one of the few plankton constituents (see p. 52). Fragments of fungi *(Saprolegnia* and others) could be found quite frequently. Diatoms, usually alive, are the most common of the algae; there is hardly a sample without them. Among the forms recognised were *Melosira,* a plankton constituent, a few benthic species, *Diatoma vulgare* growing abundantly on *Cladophora glomerata,* appeared with the highest number of individuals among the algae. In some autumn and spring collections (Nos. 4, 6, and 10, 11.) swarmers were present, in one instance they were breaking out from *Cladophora* cells (No 6, Oct. 23).

Moss leaves and the tops of tiny branches are not infrequent. Identifications were not made. As to their origin, one is apt to think of the moss patches which decorate the stones lining the banks of the bay. These stones, brought here from the geyserite hills of the neighbourhood, are renewed each year.

Animals and their fragments

The Table includes the data from the analysis of the animal constituents. An effort was made to find a grouping suitable to the material, that is why, although the elements are arranged in a somewhat systematical order, the groups are not of equal systematic value.

The animal elements were in varions conditions, as follows:

A. Living

a) Adults and those in various phases of development capable of active motion; the following classes are represented: Flagellata, Ciliata, Hydrozoa, Platyhelminthes, Aschelminthes, Chaetopoda, Tardigrada, Crustacea, Eutracheata, Arachnomorpha, Conchifera and Pisces.

b) Resting stages: eggs, cocoons, cysts, gemmules, ephippia and statoblasts.

B. Dead

Specifically the same as in A a—b. Forms where decomposition takes place immediately after death (Ciliata, Mastigophora, Turbellaria etc.) could not be found. Forms with high regenerative properties (hydra), remain alive long after they are injured (see p. 57).

TABLE I.

Number and frequency of animal constituents (living, dead, fragments) of the samples (1 cm³). Explanation of signs: S = sediment; F = floating detritus; + = present (but no numerical data); f = frequency in %; m = highest number of live individuals or fragments present in the samples (1 cm³); a = average number of live individuals or fragments in the samples (1 cm³) (drift material from Kis-öböl only being considered); * = data of quantitative investigations only being considered; numbers in fat type = living specimens; numbers inbrackets = dead specimens; numbers in ordinary type = fragments. ● = frequent, alive; o = frequent, fragments.

No of groups	Year and season	Summer of 1942						Autumn of 1942									Spring of 1943					Summer of 1943										Autumn of 1943				1944	Living material *			Fragments *		
	Date of collection	4 VI	14 VII	6 VIII		10 VIII	17 VIII	23 X	24 X	19 XI				21 XI			29 III		21 IV		24 V	17 VI	11 VII	19 VII		20 VII Aszófői-öböl bay				31 VIII	23 VIII	23 IX	16 X	24 XI		24 IV	f %	m	a	f %	m	a
	Groups / No of sample	1	2	3	3a F	4	5	6	7	8a S	8b	8c F	8d	9a	9b	9c	10	10a F	11	11a F	12	13	14	15a	15b	16a S	16b	17a F	17b	18	19	20	21	22	22a	23						
1	Mastigophora	+	1			1	1		1				1				4	+																			27·	4	1·5			
2	Rhizopoda										1		3				2														1									15·4	3	1·8
3	Epistylis, zooids		1170	65		133	110	171	260												860	●		+	973	+				198	300	100	8	160			57·7	1170	34·6			
4	Zoothamnium, colony							1											1																		7·7	1	1			
5	Peritricha, others						5	1	5				4						13														1				23·1	13	4·8			
6	Hypotricha									+	2						3	+	+						4		+										15·4	4	3			
7	Ciliata, others	+	1	4		5	7	3	8	●			5			+	1		7		●		+	+	+	+					1	1	4	1			73·1	8	3·7			
8	Spongilla, gemmules		2 40	(+)		4 30	10	9		+	27	+ +	14	+ +	+	+	13	+	12		8 60	+	+ +	+	24				+	78	41	7	3	24		+	19·2	8	4·6	84·0	78	26·1
9	Hydrozoa			1				2	1																												11·5	2	1·3			
10	Turbellaria		1	+		2	4		1								1								1						1						30·8	4	1·6			
11	Nematoda	+	+	2		4	5	4	21	+	11	+	30			+	25	+	14		5				1	+	+		+	1			14 (1)		+	+	69·2	25	10·5			
12	Rotatoria	+ +	5	13	+	16	19	1	15		+		1				3		1		2	+	+		6	+	+			+	1		4				69·2	19	6·7	3·8	1	1
13	Oligochaeta		+	+	+	3	2	1	5								3				2									1	2		2 1	2			46·2	5	2·3	3·8	1	1
14	Cocoon. Olig.			(+)		6	4	2	2				32	+			+ 11		9		4 7	+			3	+				3	25	5 7	3 3	1		+	15·4	5	3	65·4	32	8·2
15	Cocoon, others			2			9	1				+	2	+		+	1		1														1	3			3·8	1	1	34·6	9	27·1
16	Tardigrada		+	9	+	8	8	3	71 (1)		1		8				3		2 1		+												4				46·2	71	11·2	3·8	1	1
17	Eggs of Tard. in moult							2 (1) 1									+																				7·7			3·8	1	1
18	Iliocryptus						1		2																								23 (28)	1			15·4	23	6·7			
19	Alona quadr. aff.		3 (3)	(1)					2	+		+									+													35			11·5	3	2·5	3·8	35	35
20	Cladocera, others		4	1 13		1(4)32	(1)280	11	2 ○		○	+	1 1	+	+	+	16		19		20				2	+	+			2 1	21	53	130 5			+	23·1	5	1·8	76·9	280	43·1
21	Ephippium of Monospilus							14						+		+		+	14		1									2	18	17	(3) 135	1			7·7	1	1	30·8	135	28·7
22	Ephippium, others		3	+ 5		1 30	70		2 19			+	6 3	+			5		1 1		2 1	+								+			3 7	2 1		+	34·6	6	2·4	53·8	70	13·2
23	Ostracoda	+	(2) 41	+		1 18	1 50	3	2 1		4	+ +	251	+		+	1 168	+	17		43	+	+		1				+	18	157	77	2 11	14		+	19·2	2	1·4	88·5	251	54·6
24	Cyclops	+	1	1		(1)		1	9(10)3																												11·5	9	5·0	15·4	3	1·7
25	Copepoda, others					1	(1) 1	1	1 1			+		+					+ 2														(1)			+	11·5	1	1·0	23.1	2	1·3
26	Nauplius			+			2		3				1				2																1				23·1	3	1·8			
27	Corophium		2	7		2	21	2	1					(+)												+								3						27	21	5·4
28	Crustacea, not identified					8	35												5		6																			15·4	35	13·5
29	Ephemerida						1		3																								5				7·7	5	3·0	3·8	3	3
30	Chironomid, larvae and pupa		1		+						1										11				95	+	○										7·7	1	1·0	7·7	95	53
31	Prothoracal horn of Chironum, pupa	+	+				12	1	7				3				2		1		1		+		2		+			+	1	2		1						57·7	12	3
32	Diptera, larva	+ +					1		(1)				1 1								+										1						19·2	1	1·0	7·7	1	1
33	Trichoptera, larvae					4	4		1		1		1	+			3		1		9		+	+						3	7	2		1		+	7·7	1	1·0	53·8	9	3·5
34	Micronecta			5		2	13													+	11												1							19·2	13	6·4
35	Insecta, larvae	+	32	(2) 26		31	94		3												33	+								1	9		○	2						46·2	94	25·7
36	Hydracarina		1 1			2			1		1														1					1							23·1	2	1·2	3·8	1	1
37	„ , mass of eggs		(4)			3	3						1								2 3												6				11·5	6	3·7	11·5	3	2·3
38	eggs, not mentioned prev.		4		+	1	25 (3)	3	42 2		1	+	66						1		1 1					+				25	4	2	1				46·2	66	14·6	11·5	2	1·3
39	Arthropoda		122	68		181	182	47	○		○			+	+		17	+	49		15	+	+	+	33			+	+	3	48	42	○	37		+				84·6	182	64·9
40	Lithoglyphus, eggs		1	+		3	+		2		1				+		1		2		3		+		1					1	1		19	5						61·5	19	3·3
41	„ operculum										1								1				+									1		3						19·2	3	1·5
42	Bythinia, eggs			+		1		1											1		1																3·8	1	1	15·4	1	1
43	Dreissena, larva	+	5 8			+ 1	1 3				3	+ +	1 58		+	+	29	+	1		9	+	+		1	+				1 3	1 96					+	27	5	1·7	61·5	90	2
44	„ byssus	+	+	+		+	+	+	+		+		+		+		+	+		+	+	+	+		+					○	+		+	+		+				76·9		
45	Unionidae, glochidium larva		+									+	1			+	3													+	1	6				+				30·8	6	2·8
46	fragments of Mollusc. shells		4			1		5					6	+			18		1												4	6	1	2						42·3	18	4·8
47	Bryozoa, fragm. of tubes					15	18	5	2				2	+			+		3		4									1		1		2						46·2	18	5·3
48	„ , statoblast	+					2					+					1 1				+									2						+	3·8	1	1	23·1	2	1·7
49	scales of fish					1			1					+					2		3		+		1			+					1	2						34·6	3	1·6
		6 9	15 14	11 12		18 17	16 20	12	21 16		7 10		12 16	2 12	6	2 7	13 17		10 20		14 21	3 7	3 10	2 3	8 10					8 16	8 15	4 12	17 14	5 18	1	1 12						

C. Resistant parts and fragments.

a). In conection with development: exuviae of larvae and pupae of Arthropoda, Cladocera, etc., empty cases (gelatinous, chitinous, etc.) of eggs, cocoons; gemmules, etc. already hatched.

b). Indicating death: Any fragments of forms mentioned in A. a—b. For instance, the calcareous shell of Mollusk larvae of young and adult Mollusks, of Ostracoda etc. Shell of veliger and glochidium larvae and Ostracoda are not so easily broken as those of adult mussels. This ought to be due to the small size as well as to the higher percentage of organic material in those shells. Chitinous material and byssus thread have especially high resistance.

Protozoa (F=84.6%). Of this group Infusoria occur the most frequently in the samples (F = 84.6%). Flagellate Protozoa are rare, Rhizopoda being represented only by a few empty shells of *Centropyxis aculeata* and *Difflugia* sp.

Most of the Ciliata belong to the Order Peritricha, *Epistylis* being the most frequent and abundant. Colonies with zooids up to 50—60 drift ashore with substratum (chitinous fragments of Arthropoda). They also enter into empty gemmules and cocoons (Oligochaeta). *Zoothamnium alternans,* occurring on stones on the shore, is detached from the original substratum. This might be caused by the resistance of the substratum to the mechanical action of the waves. There were only a few zooids left in the colonies, while most colonies of *Epistylis,* with the exception of autumn examples, were very vigorous. *Vorticella* cast ashore attached like *Epistylis* (see Group 5, Tab. I). Hypotricha Ciliata are frequently found inside the tubelike fragments the exuviae of Arthropoda larvae, together with other Infusoria of various systematical standing (Group No 7). All these Infusoria seem to originate in the littoral, inhabiting shore waters, though the ones attached to floating chitinous remnants may have drifted ashore from the open water (neustotripton).

The delicate body of most Infusoria disintegrates quickly after death, this being very likely the reason that all the Ciliata Protozoa were alive.

Coelenterata. Gemmules of fresh-water sponges, were frequent. The majority of them belong to *Spongilla fragilis,* which is quite common on stones in the shallow water, those of *S. Carteri* being rare. Most gemmules are empty, fragments seldom seen. On one occasion a small piece of sponge was found with a few spicules and some binding material.

Not one hydra individual was found in its typical form, only degenerate (?) ones: closed tubes of small size, without tentacles (autumn samples. 1942). Judging from the nematocysts they belong to *Pelmatohydra oligactis* PALL., a species very common in our lake. Hydra in a similar condition is not rare in benthos samples collected in the shore waters. On one occassion a freshly broken piece was found from the aboral part of the body.

Turbellaria. A few free living flatworms, respresenting two species not yet identified, found alive in about a third of the samples. Their cocoons are enumerated in Group 15.

N e m a t o d a. Live round-worms are very frequent in samples taken either immediately at the water's edge or at about 1.5 m distance from it. They were exceedingly numerous in samples collected in the autumn (Nos 7, 8 d). Sometimes they are the only animals in the drift. Nematods inhabit the coatings on macrovegetation or on any kind of submerged objects („Aufwuchs") in great abundancy. Disturbed by wave action, its constituents disperse throughout the water. The worms found ashore, might be freed in this way.

Nematoda seem to be quite resistant, surviving in drifts far from the water's edge. Further investigation is, however, desirable, to decide whether all the forms found are truly aquatic or amphibiotic. Hygrophil terrestrial species might also be present. The worms found in great abundance were about *Punctodora* size, with the exception of a few large forms *(Dorylaimus?)*.

R o t a t o r i a. Freely swimming forms, those crawling about among the debris or creeping like leeches, as well as those of sedentary type, were found alive. In sample No. 1, collected after stormy days, a few pelagic forms *(Keratella cochlearis, Conochilus)* were present.

A n n e l i d a. Oligochaeta occur in almost every other sample (F = 46%) though with few individuals. Among them *Nais, Stylaria* and *Aelosoma* could be recognised, species common among the macro-vegetation in the littoral. The cases of their cocoons are highly resistant.

A r t h r o p o d a. This well represented group included few live specimens, but there were plenty of fragments. This peculiarity is perhaps in connection with the high resistance of chitinous material. Within the group Crustacea, Insecta and Hydracarina could be recognised. In the Crustacea a few specific identifications could also be made. On many occasions it was impossible to establish the proper systematical place of the fragments. Group 40 („Arthropoda") was introduced for such cases.

T a r d i g r a d a. In the summer and autumn collections of 1942, many specimens of the water bear, *Macrobiotus macronyx,* were found, but during the following year it was scarce. In a sample taken at the end of October, 1942, there were 71 individuals/cm^3, 27% of which were in the process of moulting with eggs. Eggs enveloped in the cast skin were found separately. This species lives in great population in the detritus covered bottom of shore water of section „A". During the study of the mud fauna, one example with 16 eggs was found in the mud (January 24 th, 1947). The water was covered by a layer of ice 25 cm thick, the temperature of the bottom was 3 C° (inverse temperature). Other members of the biocoenosis of the benthos were *Micronecta, Ectinosoma Edwardsii* and *Macronyx laticornis,* all of them abundant, while *Alona affinis* and chironomid larvae were scarce. Plant life was represented chiefly by Diatoms, Schizophyceae (Oscillatoria, *Gomphosphaeria, Lyngbya)* and *Cosmarium,* which were scarce. The mud, due to the long-lasting ice cover, had a blackish colour. (The lake was frozen from the middle of November, 1946).

C l a d o c e r a. One of the most common elements in drift samples are Cladocera and their remnants. (F = 80.7%). Only 5 samples were negative. This material constitutes a considarable volume too. Living (F=46%) and dead specimens (F = 11.5%) as well as ephippia with eggs (F=34.6%) and empty ones were found, fragments of shells being very common. *Iliocryptus (I. agilis* KURZ and another sp. not casting its shell when moulting), *Alona quadrangularis affinis* and *Monospilus dispar* could be identified, As to ephippia with eggs, those of *Alona, Acroperus harpae, Monospilus, Rhynchotalona rostrata* and *Leydigia acanthocercoides* could be distinguished. All the species mentioned were reported from Kis-öböl bay, some of them inhabiting the muddy bottom of the open water off its shores too. These were found at the bottom of the shallow water among floating detritus, as well as in detritus cast ashore. (SEBESTYÉN 1947, 1948). *Iliocryptus, Alona, Rhynchotalona* and *Monospilus* are common in the bottom among detritus in shore water off section „A" too).

During late autumn and early spring the free shells of Cladocera are badly damaged, but in some cases specific indentification was possible. *Alona affinis* and some striped valves *(Acroperus?, Rhynchotalona?)* were the most common among the remnants. A few exceedingly large valves in all probability belong to *Eurycercus lamellatus*, which has been recorded from the bay also (SEBESTYÉN 1948). In the case of *Monospilus* it could not be elucidated, whether the empty shells were empty ephippia or the skin of dead specimens. Ephippia in general had been found as late as May and as early as August. The presence of dead specimens of *Monospilus* and *Iliocryptus* in an autumn sample (No. 21, October 16th, 1943) might mean the end of their life cycle at the close of the favourable season. Of pelagic species only *Leptodora* (one dead specimen) was recorded.

Ostracoda. Living specimens scarce, empty shells — partly broken — very frequent and numerous. Specific identification was not made.

Copepoda. In this group *Cyclops* occurred the most frequently in summer and early autumn, 1942. They were not found the following year. Green epizoon were attached to the October specimens. Group No. 26 (Copepods not classified) was made up mostly of Harpacticidae, while the nauplii are enumerated separately. One dead individual of *Diaptomus* was found. Both *Cyclops* and Harpacticidae are common in the shore waters, while *Diaptomus* is a member of the plankton.

Of the higher Crustaceans inhabiting the lake only *Corophium* could be recognised. Though this Amphipode is very common in the littoral, no alive specimens were found. This very likely has something to do with the fact that this form is semi-sedentary, though it is a very good swimmer. Its exuviae may occasionally be found in great masses in the shore waters, but in the samples investigated remnants were rather scarce. The tube-like case of *Corophium* in a condition permitting recognition was found only in one sample.

Group 28, Crustacea, might include fragments of any of the groups already mentioned. In this group the Crustanceans were enumerated, the systematical standing of which could not be established.

Insects. Larvae of Ephemeridae, Diptera, Trichoptera and Rhynchota were recognised. The Ephemeridae are rare and not numerous. The Chironomida larvae and pupae are grouped separately from the other Diptera. Their occurrence is rare and the individual number is low. Their fragments are more frequent. It must be noted though, it was impossible not to enumerate part of them with the Diptera (Group Diptera, Insects and Arthropoda, Groups 32, 35, 39). The prothoracal horns of the midget pupa (Protenthes and other species) are very resistant and, as floating objects, they were mostly uninjured. The presence of these air sacs in drifts is known from earlier investigations (ENTZ SEBESTYÈN, and SZABÓ, p. 24, 35, 47). The larval skin and fragments very likely belong to *Cryptochironomus*, and *Microchironomus* etc, species common in the bottom of the Kis-öböl bay.

Trichoptera. Living „caddisworms" were very scarce in the samples, empty cases more frequent (Hydroptilidae, Leptoceridae).

Hemiptera. Only dead individuals of *Micronecta* and a few of their cast skin were recorded. These minute water bugs are occasionally common in shore waters, inhabiting only „deep" waters during the daytime and dispersing all over at night.

Hydracarina. A few larvae and adult specimens of water mites were present, though seldom. Fragments of their egg masses were found, as well as remnants of the gelatinous envelope surrounding the eggs.

Mollusca. Shells of *Dreissena* larvae, both in the veliger and sphaerium phase, were very frequent. This indicates the great loss takeing place at the larval stage of this mussel. The few living specimens were mostly in the sphaerium phase. Very frequent constituents of the detritus are pieces of byssus thread. The great, mechanical shock breaks the thread, leaving the surface undamaged. The shell of the glochidium larva (Unionidae) was scarce, and no living specimens were found. Though Gastropoda are rather well represented in the littoral, remnants of only two species could be recognised, viz. the corneous operculum and the gelatinous case of the singly laid eggs of *Lithoglyphus naticoides*, a very common form in our lake. Fragments of the gelatinous envelope of the egg mass of *Bythinia* are scarce. With the fragments of mollusk shells (Group 46) two young *Dreissena*, one *Lithoglyphus* and a fragment of the terrestrial form, *Cyclostoma elegans*, were enumerated.

Bryozoa. Broken pieces of empty tubes are fairly common. Statoblasts both free and stationary are in most cases empty. It is to be noted that one statoblast of *Lophopus* was found, a species not known hitherto in the lake.

Fishscales, mostly corroded, few.

In Group 38, under the title *„eggs"* are enumerated those which could not be placed with certitude in any systematical group.

About half of the groups (Nos 16—39) belong to the Arthopoda. Most of the elements originate from the littoral and benthos and many inhabit the coatings. Even the structure of the drift material occasionally bears some resemblence to that of the coating. Only a few elements originate in the open water, these being constituents of the plankton and neuston. Plankton organisms were cast ashore after stormy days. (see sample No. 1). All the elements found, originate in the lake itself (home-produced elements). Using the terminology introduced by ENTZ, SEBESTYÉN and SZABÓ (l. c. p. 31) the great majority of the elements might be considered true constituents of drifts („echte Driftelemente").

Terrestrial elements.

Allochtonous elements are mostly terrestrial („secundäre Drift-elemente" l. c. p. 32). The pollen of Coniferae growing in the neighbourhood is rather common. Hairs of *Verbascum* and *Hyppophaë* were seldom found. Fruits and seeds are of Compositae and other plants of mostly unknown origin. Along the shore in November, 1942, the fallen leaves of the poplar trees cast ashore by the waves accumulated in great abundance. Their fragments mingle very likely with the autochtonous plant debris.

It is hard to tell whether the few feathers found are those of water fowl or are blown into the water and later cast ashore. The origin of minute scales of some Lepidoptera is also unknown.

*

Because field investigations as well as the collection of samples extended over one year, — judging from the condition of organisms washed ashore, — some idea could be gained of certain events in the life of the lake.

The appearance of ephippial females of *Alona affinis* and the presence of quite a few dead specimens of *Iliocryptus* in some of the autumn samples show that the life cycle of these species came to an end at the close of the favourable season. *Macrobiotus* with eggs could be found throughout the year, showing that reproduction is not limited to a certain season, and that the species in question is eurythermous.

Forms distinguished by a high number of offspring, perish in great numbers in their early stages of development, a great loss taking place in the veliger phase of the *Dreissena* larva, somewhat less during the following larval phase, called sphaerium.

When the water level is falling organisms inhabiting the organic sediment on flat shores are left dry. They survive as long as some water remains among the particles. Detritus left on shore in such way, could not be considered as true drift, though the destiny of its microfauna is similar to that of drifts. However, a difference exists between them viz. the construction of the original biocoenosis could be recognised in the first case, while in the material washed ashore, the selective power of the wave action might change its structure.

The most resistant animal substances seem to be chitin and spongiolin, but even in the case of these, a mechanical destruction, through the dislodging force of the waves, prepare them for the activities of specific bacteria which play a rôle in the decomposition of such substances.

CONCLUDING REMARKS

Formation and material of detritus drifts were investigated in an appropriate section of the shores of the Tihany peninsula, Lake Balaton.

Field observations and qualitative and quantitative laboratory analysis of 35 samples collected from June, 1942, to April, 1944, were involved in the study, followed by an evaluation of the data gained from systematical and ecological points of view. The aim was to elucidate 1) the origin of the various plant and animal constituents in the drifts, 2) the process of fragmentation, and 3) the rôle and significance of detritus drifts in the cycle of matter in Lake Balaton.

The bulk of the samples is made up of organic particles.

The origin of the organic particles is threefold: 1) fragments of macrovegetation; 2) dispersed elements of the coating of various substrata detached by the waves; 3) organic debris of the bottom of the littoral.

With the fragments of higher vegetation other plants of low systematical rank mingle, such as mosses, fungi and algae, filamentous forms being the most frequent among the latter.

Data on animal constituents belonging to 49 groups (not of equal systematical value however) were united in a Table showing the presence and individual numbers of the various animal constituents (alive, dead, fragments) in each sample: frequency of distribution calculated in %, maximal and average individual numbers of all the material investigated quantitatively are also given. About half the groups belong to Arthropoda. Most of the animals originate in the littoral and benthos, many inhabit the coating. Only a few elements are from the pelagic region.

Beside these autochtonous ingredients some of terrestrial origin might also be found. The origin of seeds and fruits is largely unknown.

Condition of the bodies of plants and animals differs according to the length of time they have been detritus constituents. The particles represent various stages of mechanical disturbance and chemical decomposition. Part of the plant debris is of turfy appearance.

All these constituents have come under the rule of wave action, which disperses them in the medium and when the dislodging force is sufficient, they may be washed ashore where the topography is suitable.

The selective power of wave action takes part in the gathering of the particles and their disposal on the shore, though in this process the shape, size and specific gravity of each ingredient plays a rôle too. The locomotion of an active organism might come into play but only in the case of very gentle motion of the water.

The most frequent size of the plant debris is about 0.5—5.0 mm, besides which finely distributed particles are also present. Sedimentation of such fine particles is exceedingly slow, and this makes the transportation of the fine detritus into the free waters possible.

Though fragmentation of the macrovegetation takes place gradually, it seems that there is a gap in size between coarse and fine detritus. It seems also that fine detritus may be formed at any stage of fragmentation. The matter of size however should be approached only by collecting many exact numerical data on the material.

The detritus drifted ashore lies there for a longer period, it dries, becomes fragile, and may break up gradually to fine particles under various mechanical influences and might be carried away by the wind or washed into the water immediately.

Fine detritus which remains in the shore water, might be consumed by members of the benthos. Most of the coarse detritus remains in the littoral and as bottom sediment forms a biotope for a characteristic biocoenosis made up of various microorganisms. (A thorough study of this biocoenosis will follow in the near future.) Coarse detritus might serve as food too, but this question needs special investigation. Most of the fine particles are transported to the open water district, and might form an essential part of the seston from a trophical point of view. Benthic forms might feed upon it, when sunk.

Through the effect of wave action plant and animal bodies might become subject to fragmentation before raching the end of their life cycle and the organic substance represented in them, by the intervention of detritus formation, detritus feeders and their consumers etc., may be transformed into live matter again, delaying the process of complete decomposition.

July 21, 1948, Tihany.

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К ВОПРОСУ О ТЕЧЕНИИ ДЕТРИТА В ОЗЕРЕ БАЛАТОНЕ

Автор: ОЛЬГА ШЕБЕШТЬЕН

РЕЗЮМЕ

Мы исследовали формацию и состав детрита около подходящей части берега полуострова Тихань в озере Балатон.

Основой для данных исследований послужили наблюдения в поле, далее качественный и количественный лабораторный анялиз 35 проб, забранных с июня 1942 г. по апрель 1944 г.

Далее произведена оценка данных со систематической и экологической точек зрения.

Нелью наших исследований являлось:

1. Выяснение происхождения различных видов флоры и фауны в течениях.

2. Процессы фрагментации.

3. Выяснить роль, значения и влияние течения детрита на процессы в обмене веществ в озере Балатоне.

Главную часть проб состовляют органические частицы. Эти частицы происх дят из трех источников:

1. Фрагменты макровегетации.

2. Дисперсные частицы, оторванные волнами от поверхности разных субстратов.

3. Органический нанос со дна побережья.

Фрагменты более развитой вегетации смешиваются с растениями более низкой систематической категории, как мхи, грибы и водоросли. Среди последних чаще всего встречаются нитевидные формы. В таблице собраны данные относительно органических составных частей, принадлежащих к 49 группам (различных систематических категорий). Эта таблица указывает на наличие и число разных органических составных частей (живых ,мертвых, частиищ) в каждой отдельной пробе. Там-же привелены частота их распределения в %-ах, далее, максимальное и среднее число всех исследованных материалов. Приблизительно половина всех групп принадлежит к члеиистоногим. Чаще всего животные происходят из воды побережья и бентоса, многие однако живут на поверхностной оболочке. Только небольшое число составных частей, найденных после бури, происходит из пелагической области. Кроме этих автохтоных составных частей, иногда встречаются и частицы почвенного происхождения. Происхождение семян и фруктов по большей части неизвестно.

Состояние тел растений и животных различное в зависимости от срока пребывания в детрите. На этих частицах наблюдать разные стадии механического размельчения и химического разложения. Известная часть растительного детрита имеет торфяной состав.

Все эти составные части подвержены действию волн, которые рассеивают их в среде, а если сила размещения достаточна, волны вымывают их на побережье, на места соответствующей топографии.

Динамическая сила действия волн оказывает влияние на группировку частиц и на их распределение по побережью, хотя в этом процессе и форма, размер и удельный вес отдельных составных частей играет известную роль. При очень слабом движении воды и движение живого организма участвует в этом процессе.

Размер растительного детрита колеблется чаще всего от 0,5—5 мм., кроме того встречаются и более мелкие частицы.

Седементация таких мелких частиц происходит крайне медленно и это делает возможным перемещение мелкого детрита в открытую воду.

Несмотря на то, что размельчение макровегетации происходит постепенно, очевидно имеется пробел в размерах между очень мелким и крупным детритом.

Очевидно мелкий детрит возникает в каждой стадии размельчения. Вопрос о размерах, однако, можно решать только путем исследования многочисленных достоверных данных.

Детрит, вынесенный водой на побережье, вследствие долгого пребывания на берегу, высыхает, становится более ломким и — под влиянием различных факторов постепенно размельчается до самых мелких частиц, откуда ветер и вода впоследствии удаляют его.

Мелкий детрит, оставшийся в воде побережья, употребляется членами бентоса. Большая часть крупного детрита остается на побережье, или в виде осадка на дне. Он там образует биотоп для характерного биоцэнеза, состоящего из разных микроорганизмов. (Подробное исследование этого биоцэнеза вскоре будет произведено.) Крупный детрит может служить и в качестве питательного материала, но этот вопрос требует дальнейшего изучения.

Главная часть мелких частиц выносится в открытую воду и там с трофической точки зрения составляет существенную часть сестона. Формы бентоса могут пользоваться етими частицами, когда они опускаются на дно.

Вследствие действия волн, растительные и животные тела могут подвергаться размельчению — еще не окончив полный цикл своей жизни, а их органический материал, вследствие формации детрита, действия производителей и потребителей детрита и т. д. может опять превращаться в органические вещества, отсрочивая таким образом процесс полного разложения.

31-го июля 1948 г. д. Тихань.