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ALGOLOGICAL AND HYDROLOGICAL INVESTIGATIONS INTO ALKALI SOILS, WITH PARTICULAR REGARD TO THE PROBLEMS OF WATER UPRUSHES AND "VARIETY OF COLOURS"

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Abstract

A characteristic peculiarity of the alkali soils in Hungary is the "variety of colours", the mosaic-like heterogeneous character. That is to say: the physical, chemical and biological peculiarities of the soil may change within comparatively small distances. On the basis of our algological and hydrological investigations, carried out for several decades, we see so that this is in connection, in a very high degree, with the different forms of the water uprushes which have less been investigated, until now. The spotted water uprushes are coloured with remarkable algal mass-productions. In this paper, some water-uprush forms of algal mass-productions are discussed from the dried-out bed of the central lake Fehér-tó of Kardoskút-puszta in County Békés and its environs.

Introduction

I have dealt with the algological investigation into the home alkali waters for 50 years. In my younger days, I have walked much on the alkali soils of my native land and I wanted even to be an agriculturist. I have therefore, received with great joy Professor Pál Greguss's suggestion in 1929, to deal — as a subject of my diploma work — with the algological investigation into the alkali waters at Orosháza. My diploma work was made for the assigned date (Kiss, 1933). I continued my investigations and my doctoral thesis was also published from the same domain (Kiss, 1939). An now, remembering this, I am presenting this work of mine to the 90 years anniversary of Professor Greguss's birth. In addition, I have dealt from 1934 with the algae of alkali soils, as well. I was particularly stimulated to this by the agricultural scientists Imre Török and Lajos Kreybig, providing for me also an opportunity to do this as a junior lecturer in the Department of Agronomics of the Teachers' Training College in Szeged. Further on, this has proved to be very useful.

At my summer research trips in the environs of Kardoskút, Békéssámson and Mezőhegyes, on the fawn-coloured "burned out" grass of the dry pastures I often observed fresh-green grass spots of moist soil. In the environs of Kakasszék and Kardoskút-Puszta-Centre, my attention was even more drawn to the drying-out lake-beds, from the greyish-white terrain of which the dark and muddy spots of the water spouts could already be seen well from far away. These were often coloured by algal mass-productions, as well. On the ground of an old agricultural tradition, these spots have — not inaptly — been called "springs" or "springlets" by people there. This term generalizes the observations of some centuries and it seems worth taking this into consideration in the specialized branch of science, as well.

During the past five decades, I surveyed the considerable enough alkali areas of Hungary. I have visited in the territory east of the river Tisza 60, in the region between the rivers Danube and Tisza 73, along the rivers Bodrog—Zagyva—Tisza 3, and in Transdanubia 19, i.e., totally 155 alkali waters, lakes and investigated into these from algological point of view. I have everywhere sought for the phenomena of water uprushes but the most typical ones of them proved, so far, to be those observed in the environs of Kardoskút and Békéssámson. It is true that I have investigated into these regions for long decades. To the water uprushes at Kardoskút those of the lake Kelemenszék-tó on the western confines of Fülöpszállás, as well as those of the lake Sós-tó at Sárkeresztúr are the most similar (KISS, 1976a; 1976b). They are worth while to be investigated further on.

Concerning water spouts, I have found two interesting series of data in the home special literature (KISS, 1976a; 1976b). MADOS wrote an appreciation of the importance of hydrological conditions in soil research. According to him, "Scherf's theory concerning the origin of the bulk of salts, the co-operation of soil water, and generally from geological point of view, may be qualified as absolutely acceptable but without Sigmond's explanation of phenomena it is not complete." His following statement is particularly important from our point of view: "It is undeniable that the soil water under pressure can break through the bas aquiferous layer even in a period when it already became impermeable for rainwater. In this way, salts can get into the upper soil and there will be no opportunity later any more to leach it below the layer becoming impermeable". He establishes further on that "... the rising of salts by the subsoil water and the eluviation of the soil in alkali medium, as a phenomenon conductive to alkalization, don't contain any contradiction but they give even together the full explanation of the course of alkalization". In the fundamental book of ARANY, I have found references to water spout in two places. He mentions on page 156 of a characterized place: "Partly the configurations of the surface of its terrain, partly the position of the sub-soil layers are such that not only the surface water assembled together upon them but their subsoil-water stood very high, as well, and even it rushed up on the surface, too." On page 157, he writes of the area which stood under water before: "The surface water ran here, for the most part, from the adjacent higher lying regions, to the deepest-lying part of the environment, and, at the same time, the underground water-level sometimes stood so high that it got to the surface."

The phenomena a water spout, described by me from the environs of Kardoskút and Békéssámson (KISS 1959; 1963; 1968; 1969; 1970a; 1970b; 1971a; 1971b; 1971c; 1972a; 1972b; 1974; 1975; 1976a; 1976b) may be reconciled well with the hydrological researches relating to the subject (RÓNAI, 1956). Rónai has ascertained that the most developed zone of high subsoil water of the southern territory east of the Tisza extends north-west from Dombegyháza towards Orosháza, then from there to the south through Békéssámson until the environs of Csanádalberti. The underground-water level lies here 1–2 m deep below the surface. In the province Alberta of Canada, hydrogeologist J. TÓTH described some water-spout phenomena, very similar to those at Kardoskút (TÓTH, 1966; 1969; 1971). He mentions that people there also know the water spouts called "springs", "springlets" at Kardoskút and call these "soap hole", "mud spring" or "mud volcano", according to their differences. He demonstrates these with coloured photographs, as well

The hydrology of water uprushes, their forms and role in the "variagation" of alkali soils

Our home alkali soils are characterized by a spotty "variety" of colours. The essence of this is that within comparatively small distances, sometimes almost step by step, the physical, chemical, biological and other properties connected with the level may change. About this, I have earlier formulated the following opinion (KISS, 1969): *"In all probability, we are not far from reality supposing that the spottily disproportionate distribution of the subsoil water belongs to the basic nature of alkali soils and that the phenomenon of spotty variegation is mostly in connection with the spottily disproportionate distribution of subsoil water"*. It can also be told briefly: *the "variegation" of alkali soils is a consequence of the "variegated" water conditions.* As, anyway, the disproportionate water conditions are brought about by the open and concealed forms of water uprush, *the phenomenon of water uprush is the central problem of the hydrology of alkali-variegation.* The essence of water uprush must, therefore, be interpreted.

Essence and forms of the water uprush

If at some spot the subsoil water rises close to the surface or until the surface, water uprush comes about. In this, the capillary water motion has some part but the primary cause is much more that the water moving in the different ducts is under a pressure from below, mainly a hydrostatical pressure, rising the subsoil water through the water-sealing layer, in repeated rhythms towards the surface. And the unequal water-conductivity of soils, soil layers, in case of the soils beginning to be alkalized, may originally be attributed to that the accretion of the one-time water-courses occurred unequally, in a "disturbed" way. *The unequal siltation masses up some layers upon or beside one another more or less water-conductive or water-sealing layers, conducting the water towards the surface spottily, unequally.* In the subsoil, there are also *water-conducting ducts, "rills"*. This similarly contributes to bringing about or increasing "variability". We have observed that the unequal water pressures may from time to time even change somewhat their places. By this, the picture of soil structure or soil composition, induced already before, can repeatedly be modified. It was only by supposing this that we could explain the fact that the terrain, created by river siltation and alkalization, is composed of spots, differing from step to step from one another. Interpreting the alkali-variety, the results — apart from paedology and agrochemistry — also of geology and hydrology ought to be integrated. To the first approximation, the two latter ones are necessary, too.

In the following, I will present a few cases of the water uprushes, observed on the confines of Kardoskút—Puszta-Centre and Békéssámson, classified in some main forms. These will sometimes be completed with those observed in other alkali lands, too.

Main form I:"Spring"-wells or overflow wells

At the southern side of the lake Fehér-tó at Kardoskút, the well of Farkas's farmstead may be considered as a "classical" example (Fig. 1). At the end of Winter, the cavity of this is completely filled with water, rusing up from 2–3 "rills", sometimes so much that the water runs out under the brim of well, resp. through the leaks

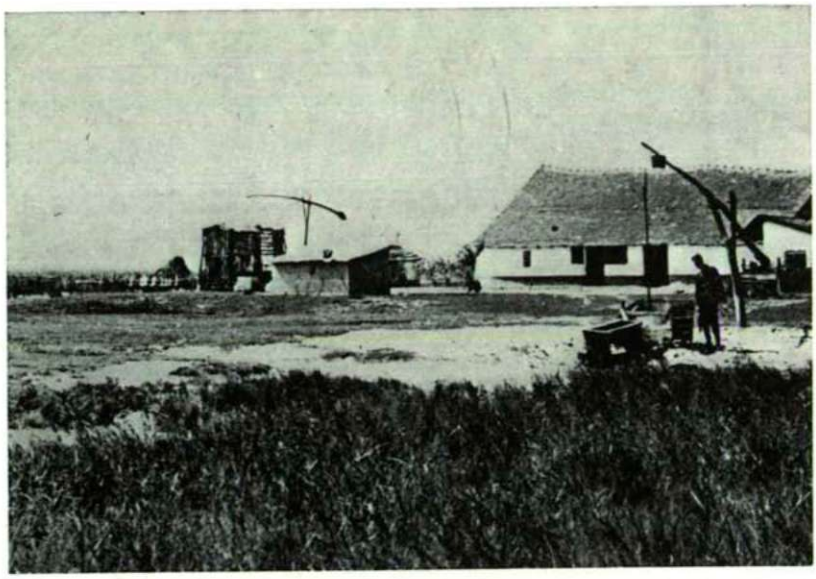

Fig. 1. Overflow-well in Kardoskút-Pusztaközpont, in the farm-yard of the farmstead of István Farkas. From the full basin of the well, water runs into the lake or the dips of the yard per Springs.

of the 1–2 upper rows of bricks of the well-lining, into the deeper-lying lake. In some years, this runningout incessantly endures till the beginning or middle of Summer. Now and then we also measured the water production of the well approximately. We scooped out of the well 10–12 pails of water and observed, during what a time it will be supplied. On 9 May 1962, e.g., about 6–8 l water ran out per minute, on 29 May about 3 l, and on 10 August already hardly 1 litre. But even in this way, during a few months much more than 100 cc.m water could get into the lake. Later on, the height of the well above the level of the Adriatic was measured by the head of the department, VÁGÁS, and since then, the water production of the well has continuously been recorded. In 1942, on the occasion of the inland waters of inundation character, some wells like this were also observed by KREYBIG in the area of the loess banks of the Békés—Csanád region. In 1935, in the steppe Eperjes-puszta, north of Orosháza, I myself also saw a "spring"-well, corresponding to that in Kardoskút, in the farm-yard of the then Traum's farmstead. In 1973, in the region of Hungary beyond the Danube (Transdanubia), at the fringe of the village Sárkeresztúr, I also heard of a well like this. The occupants of the house No 1 of Imre-major reported on their well that it "overflows" every Spring. The water of these wells is fit to drink.

Main form II: Remarkable water uprushes in the dry basin of the lake Fehér-tó

We have investigated from algological point of view dozens of water uprushes in the dried-out basin of the lake Fehér-tó at Kardoskút. The surface of the dry basin is covered with a greyish-white "efflorescence". This is partly salt, partly

dehydrated silicic acid, originating from the decomposition of the adsorptive complex. The pH of this crusty and later dust-like "desintegrating" basin surface mostly fluctuated between8.5 and 9.2. The total salt content of the condensed water of the lake is very important. According to Szépfalusi's analyses, for instance, at Farkas's farmstead, in July 1963 20,000 mg/l and in July 1964 40,000 mg/1 total salt content was observed. The alkali character of the lake Fehér-tó also comes from the too large quantity of natrium hidrocarbonate. The Na^+ amount can increase to the value 32,000 mg/l in a water condensed at the middle or end of Summer. At the same time, the amount of hydrocarbonate may exceed the value 9000 mg/l, as well. The carbonate content may rise over the value 4000 mg/l in mid-July and the chloride content then already also exceeds the value 1500 mg/l. The chloride value was outstanding on 6 July 1963 when in the condensing water a quantity of 4000 mg/l was demonstrated by analysis. Sulphate is also considerable; until Spring it is 140 mg/l; in Summer, however, it is less. The water is surface water, in respect of cation with natrium-magnesium, and in respect of anion with carbonate-hydrocarbonate-chloride (SZÉPFALUSI, 1963). The ratio of cations and anions is not everywhere alike; this particularly turned out from the fluctuation of the relation between Ca^{++} and Mg^{++}. In the water samples, collected in the area close to Farkas's farmstead, the fluctuation of these cations is of definite character; more to west, towards Czuczi's farmstead, however, Mg^{++} always dominates. The phenomenon of spotty "variety" manifests itself, therefore, here, too, which can be reduced to the spotty differences of the soil, resp. to the partial promotors of these, the water uprushes. The everywhere appearing "variety" must obviously be connected with the geological past of this area, as well. According to MOLNÁR and MUCSI, the present-day lake basin consists of two ancient river-bed parts and the history of the latter ones has differred since the Pleistocene (MOLNÁR, MUCSI, 1966). The western part of the lake is — according to our investigations much richer in water uprushes. Here the water of the well in Czuczi's farmstead has a pH-value at least a few decimals higher than the water of wells being towards east, in Farkas's farmstead.

A searching chemical analysis of the soil of spots with water rushes might similarly manifest a further "varied" picture. The different places of the same spot can namely differ from one another in respect of pH, as well. In the marginal parts of spots is, namely, the pH-value mostly higher. In the following, we display a number of plots.

1. A spot with a muddy water uprush (Fig. 2)

Date of observation: 2 October, 1961. The pH of the surface at the marginal parts is 9.3. The 3×2 m large area is of slipperily muddy surface, sharply delimited from the adjacent dry lake basin of greyish-white "efflorescences". It is visible in the picture, too, that the muddy surface slightly bulges. At the lower margin of the picture, the initiatives of fissures originating from the loss of water are well perceptible. In these, sometimes, water was still shining. By this is shown, too, that the pressing-up of water to the surface ceased to be 1 or 2 days earlier. The spot was, almost in its whole extent, brownish-green and it had sporadically a strongly glistening surface. The colouration was induced by the mass production of algae

Fig. 2. A somewhat bulged, dark and muddy stain of water-uprush in the extincted lake-bed of the lake Fehér-tó at Kardoskút. Its surface is stained by algal mass-production.

and the glissening by the appearance of colloidal matters of greasy touching. The algal species of the mass-production are as follows:

1. *Gloeocapsa turgida* (KÜTZ.) HOLLERBACH
2. *Coccopedia limnetica* TROITZK.
3. *Anabaena variabilis* KÜTZING
4. *Oscillatoria Lemmermanni* WOLOSZ.
5. *Oscillatoria brevis* KÜTZING
6. *Pelonema* spec. *(*of larger size then *P. pseudovacuolatum*!*)*
7. *Phormidium papyraceum* (AGARDH.) GOMONT
8. *Gongrosira trentepohliopsis* (SCHMIDLE) var. *natrophila* KISS. I.

In the algal mass the remains of flint shells could also often be seen but on the basis of these the here-found Bacillariophyceae species could not be determined.

2. Dry spot, with already "disintegrated" water uprushes (Fig. 3)

Date of observation: 22 September, 1963. The pH of the mouldering substance of the soil surface is 9.5; in the environs only 9.00. The length of the spot of long drawn-out elliptical shape is 5.3, its width is 1.7 m. This is of surface, already granularly disintegrating because of becoming dry. Its colour is clearer than that of the adjacent lake basin which is similarly granularly-dustily disintegrating. In the spot the salts, resp. the dedydrated silicic acid may be present in a rather large quantity. This spot also protrudes a little from the terrain. The dry lake bottom is covered

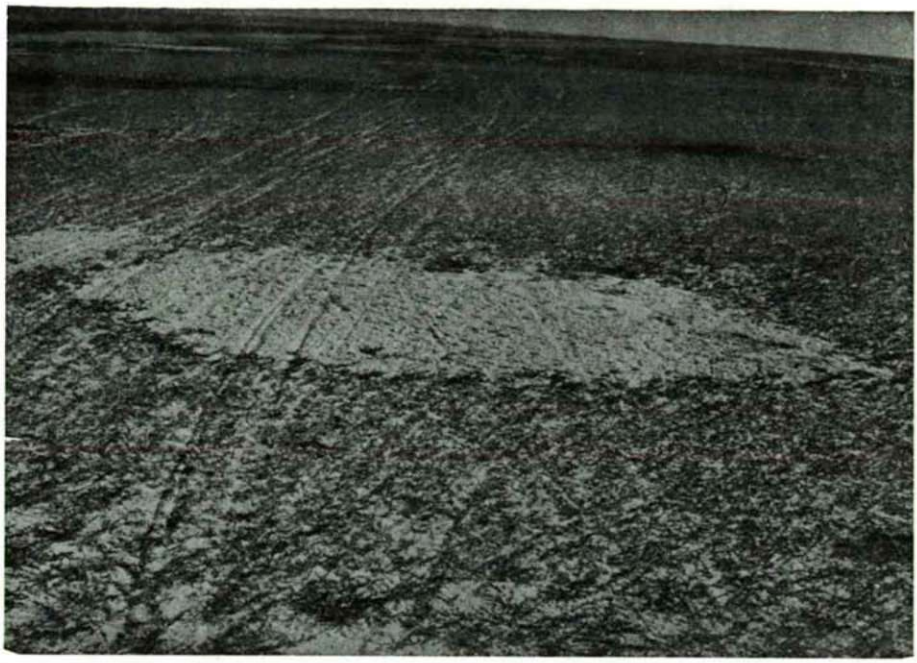

Fig. 3. A granulously bulging "blind-alkali" stain, covered with dust, in the bed of the lake Fehértó at Kardoskút, resuline from the extinction of a stain of water-uprush. Here and there, its surface is stained by algal mass-production.

with the stands of *Suaeda maritima* (L.) DUM. ssp. *prostrata* SOÓ. The spot with water uprush is, however, "blind-alkali". Here the formation of macrovegetation may have been impeded partly by the crumbling, partly it is here and there of "rummaging" character. In some places of the blind-alkali — regradation spot, palm-sized or smaller algal mass-production spots appeared. These may have been the remains of an earlier, more uniform "soil blooming" (flos humi). Two spotlets may even be seen at the right margin of the picture. On the place of the algal mass-production spots the soil surface is less disintegrated into a granular-dusty substance. Under such a surface, remaining compact, in a depth of 2–3 mm, a newer colouration could be observed, the crypto-vegetative mass-production of algae. About 1–1.5 cm deep, the area below the cloddy-granular crumbling was also slightly coloured, as a result of the further spreading of the cryptovegetation. The constituents of the algal flora are:

1. *Gloeocapsa minuta* (KÜTZ.) HOLLERBACH
2. *Oscillatoria brevis* KÜTZING
3. *Lyngbya Martensiana* MENEGH.
4. *Gongrosira trentepohliopsis* SCHMIDLE var *natrophila* KISS. I.

This crumbling spot reminds us, to a certain extent, of the alkali spot that is shown in Professor ARANY's book, in picture 12, about the sand in Nyíregyháza. The question is, how many are the common traits in the formative processes.

3. Spots of water uprushes with *Bolboschoenus maritimus* stands (Fig. 4)

Date of observation: 28 September, 1958. The spots of water uprushes overgrown with *Bolboschoenus*-stands, have lined up, and do this mostly today, as well, mainly in the southern part of the western half of the lake, close to the lake-side. The spots are of irregular form, their diameter may be from 2–3 m even till 15–20 m. The most conspicuous trait is, here too, that the surface of the soil is wet, sometimes even boggy, but the surfaces of the bottom of the lake without water uprushes are entirely dry and creviced. It is well-visible in the picture that the spots of water uprushes somewhat bulge from the terrain, as if cushioned; with their entirely unbroken surface they are sharply delimited from the places of the bottom of the lake, full of crevices and without water uprushes. The vegetation covers, as a rule, the middle part of spots. The pH-value fluctuated between 9.3–9.7 in the spots of water uprushes. In other parts of the bottom of the lake, the pH was of some decimals less value. The surface of the at least moist-wet spots is covered with algal mass-productions. The nuances change even within the single spots what refers to the

Fig. 4. In the bed of the lake Fehér-tó, on the stains of a water-uprush, the thalli of *Bolboschoenus maritimus* appear in some places. On the fringe of vegetation it is visible that the smooth surface of the ground shaprly differs from the crevassed surface of the lake-bed.

differences in composition of the constituting algal populations. In the spot on the left of the foreground of the picture the following species were found:

1. *Oscillatoria brevis* KÜTZING
2. *Phormidium foveolarum* (MONT.) GOMONT
3. *Phormidium fragile* (MENEGH.) GOMONT
4. *Phormidium tenue* (MENEGH.) GOMONT

Algal samples were taken from 10 spots together. Among these there were some populations much richer in species but the former four species occurred in all of them. Similar species covered with *Bolboschoenus* stand also occurred on the confines of Sárkeresztúr and in the basin of the lakes Sós-tó, Nagyvadas-tó and Fehérszik-tó at Tiszavasvár. Particularly, the spots of water uprushes on the bottom of the lake Fehérszík-tó were swampy most usually. It occurred that here, on one of the spots, a foot of one of us sank in the mud about 40 cm. At any rate, the surface of spots is, as a rule, not boggy. Some algal mass-production occurs in case of all of them but not with an identical algal flora. These, however, cannot be treated here at length.

Main form III: Hidden water uprushes on a higher terrain

Water uprushes can develop not only in the basin of the lake Fehér-tó but in the adjacent pastures, plough-lands and even within the buildings, as well. On these we have several data from Kakasszék, Kardoskút—Puszta-Centre and from the confines of Békéssámson.

Now, we discuss two cases from Kardoskút.

1. Fresh green grass spots in dry alkali grasslands

At the southern side of the lake Fehér-tó at Kardoskút there is an old grass composed by the stands of *Festuca pseudovina* HACK. ap. WIESB. In this, for about 20 years, I have kept under observation two grass spots that, even in the time of summer drought, rise above the grass-stand turning yellow, with their fresh green colour. In both grass-spots of moist soil, *Aster tripolium* L. ssp. *pannonicus* (JACQ.) Soó occur in large numbers, and *Trifolium fragiferum* L. and *Trifolium angulatum* W. et K. as well, are frequent, too. On 19 July, 1962, in the larger fresh green spot, we dug a deep pit and, about 4 m from that, in the grass of dry soil, becoming yellow, we dug another the depth of which was about 0.7 m. The wall of the pit made in the fresh green spot began to be wet downwards from a depth of 20 to 25 cm and, about in an hour, it became almost "perspiring" as a result of the appearance of the well-visible water-drops. These, running downwards, made the bottom of the pit muddy. On the wall of the pit, dug in the dry grass, we did not observe any moisture after hours, either. The investigation with the method of pit-pairs was later on repeated on two occasions, with approximately similar results. Between the gaps of the fresh grass spots alga-induced colorations could also be observed. Their constituants are as follows:

1. *Gloeocapsa chroococcoides* NOVACEK
2. *Oscillatoria brevis* (KÜTZ.) GOMONT
3. *Lyngbya Martensiana* MENEGH.

We have often observed fresh green spots of moisty-wet soil, like these, on the confines of Békéssámson, as well. These were, hiddenly, also of "springlet" character.

2. Water uprush appearing in the living-room (Fig. 5)

It is an old experience that in "humid" years the lower part of buildings with adobe walls decays, "corrodes", becomes softened by the water coming from below. This may induce the sinking of the wall. In the living-room of Czuczi's farmstead at the south-western side of the lake Fehér-tó at Kardoskút, on 9 May, 1962, the farmer called our attention to a spot of water uprush in a corner of the room. This made so soft the tamped loan "flooring" that there the chair-leg sank. The wet spot existed for years and in October, 1965, the lower part of the wall sufferred damage as shown in Figure 5, and the wall was in danger of tumbling down. In May, 1968, this farm-house became crooked, its windows and doors were removed. In the corner of the living-room with water uprush we found a bluish-green algal mass-production on 19 May, 1968. This was induced by the following species:

1. *Oscillatoria brevis* KÜTZING
2. *Oscillatoria amphibia* AGARDH
3. *Schizothrix lardacea* (CES.) GOMONT

The building soon tumbled to pieces together with other buildings and the owner made a new building near tho old one on such a place that he new to be free from water uprushes. In this time, in the vicinity of the lake Fehér-tó at Kardoskút—Puszta-Centre a few other farm-steads collapsed, as well, mainly owing to the damaging effect of water uprushes. Such damages of water uprushes from the region of the rivers Maros and Sebes-Körös are known and they are first of all connected

Fig. 5. The wall of the farm-house is ruined by a water-uprush. In one of the corners of its room, the floor is also sodden by the water-uprush to be swampy. Here later an algal mass-production was formed.

with flood prevention. From the environs of Makó, the following were written by MÁRTON sixty years earlier: "On the occasion of floods, large devastations are induced by the up-welling water. The cellars are filled with water, the plough-lands in the neighbourhood of levees are covered with up-welling water. Into the earthen floor of the houses, built in the rather flat part of villages and belonging, as a rule, to poor people, which are bulking of welling-up water, the chair-leg generally sinks in if somebody sits down on them." (MÁRTON, 1914). The matter in question is here that the welling-up waters occur at the flood of the river Maros. Close to the river Sebes-Kőrös, at Kőrösladány, in the days of the large flood in 1970, in the kitchen of the house MÁRTON NAGY street No 3, near the levee, a water uprush appeared, known at present in flood defence works as "buzgár" (bubbling-up flood). Half part of this short small street was to be demolished because the houses became dangerous to life. Today a vegetable garden is in the place of houses.

Main form IV: Marsh uprushes

Their essence is that the rushing-up water cannot directly reach the surface but it softens certain layers of the subsoil so much that these are transformed into a marshy mass and pressing upwards the moistening surface, they induce there a bulge. We have observed a number of cases but now we can only demonstrate one of these.

1. A bulging marsh uprush at Kardoskút—Puszta-Centre in 1970 (Fig. 6)

In the days of the Great Flood Defence Work in the Lower Tisza Region, in Spring 1970, dramatic events took place at Kardoskút—Puszta-Centre, as well. At the lake Fehér-tó, bulging marsh uprushes were observed in two places. One of these was directly south of Czuczi's farmstead, the other at the eastern end of the lake. The former soon "welled up" and "ebbed". That at the eastern end of the lake, however, only shrank and became lower but, in this case, too, its relative height reached 30 cm. In Spring, the bulging still sagged under the body weight, in Autumn, however, it only trembled under footsteps and a crevice of north-south direction began to form in it. This is shown by Figure 6 from 6 November, 1970. The surface of the hump is bare along the crevice, its pH-value is 9.2. On the sloping part of the hump *Puccinellia distans* (L.) PARL. became acclimatized in bunches. The inner, still mostly wet, surface was here and there covered by green or blue-green algal coating. In forming this, the following species have taken part:

1. *Myxosarcina spec.*
2. *Oscillatoria brevis* KÜTZING
3. *Oscillatoria angustissima* W. et G. S. WEST
4. *Lyngbya Martensiana* MENEGH.
5. *Chlorococcum infusionum* (SCHRANK) MENEGH.
6. *Planophila laetevirens* GERNECK.

I continued examining this forming of a hump in 1971, and it could be ascertained that below the about 30 cm thick hard soil layer of the bulge such a marsh-like soaked "soil-lens" takes place that is strongly convex on its lower side but on the upper side it is only flatly bulging (KISS, 1972). The largest thickness of this

marsh-like soil-lens, about at its middle part, somewhat surpassed 2 m. The substance can be considered mostly as gley and immediately under the crevice it is of pseudo-gley character. At the lower part of the ample crevice, as well as on the desiccated surface of the soil-lens below the crevice, an algal mass-production manifested itself. I have examined the composers of this on 16 August and 31 November. My results are the following:

16 August:

1. *Synechococcus elongatus* NAEG.
2. *Gloeocapsa salina* HANSGIRG
3. *Myxosarcina spec.*
4. *Anabaena variabilis* KÜTZ. f. *tenuis* POPOVA
5. *Oscillatoria brevis* (KÜTZ.) GOMONT
6. *Phormidium ambiguum* GOMONT
7. *Lyngbya Martensiana* MENEGH.
8. *Schizothrix lacustris* A. BRAUN
9. *Tolypothrix spec.*
10. *Anomoeoneis sphaerophora* (KÜTZ.) PFITZ.
11. *Navicula gregaria* DONK.
12. *Chlorococcum infusionum* (SCHRANK) MENEGH.

31 October:

1. *Myxosarcina spec.*
2. *Anabaena variabilis* KÜTZ. f. *tenuis* POPOVA
3. *Oscillatoria brevis* (KÜTZ.) GOMONT
4. *Phormidium ambiguum* GOMONT
5. *Lyngbya Martensiana* MENEGH.
6. *Tolypothrix spec.*
7. *Anomoeoneis sphaerophora* (KÜTZ.) PFITZ.
8. *Chlorococcum infusionum* (SCHRANK) MENEGH.
9. *Planophila asymmetrica* (GERNECK) WILLE
10. *Gongrosira trentepohliopsis* var. *natrophila* KISS. I.

The role of water uprushes in the "variegation" of the alkali soils

On the basis of my experiences of several decades I see so that the processes of water uprushes are one of the decisive factors, pivotal questions, of the mosaically heterogeneous character, "variegation" of alkali soils. This follows, at any rate, already from the generally accepted opinion, too, that the alkali soils are hydrogenetic soils. That is to say, in the course of their formation and further changes, the motion of the subsoil water and surface water is of decisive effect.

On the surfaces of water uprushes also tiny, 1–2 mm holes can be observed, mostly in dry state. If we walk on the spot which is still in muddy state, from the small holes water uprush, bursting-out may be observed. I have often experienced, too, that the immediate environs of the small holes represent a one or two mm "higher" terrain and that here the surface is richer in grains of sand than the farther places of the uprush. Otherwise, it can be seen even in the presented pictures that

the spots of water uprushes stand out a little from the bottom of the lake, almost as small "cushions". The spouting water can namely bring matters from below the surface which get gradually separated from the water spreading in all directions on the surface. First the drifted grains of sand settle down, then the clayey, colloidal matters get separated, the dissolved salts getting the farthest. The separation of these takes place according to their solubility.

Some qualitative differences may manifest themselves even within the already formed spots of water uprushes. On the major spot which is already dried or drying up, minor sub-spots appear, corresponding to the pressure fluctuations of the repeated water uprushes, resp. of the subsoil water. The differences of minor spots are also indicated by the algal mass-productions. These coloured "soil efflorescences" ("flos humi") represent changing populations, sometimes within even cm distances. The appearance of algal mass-productions refers to the effect of certain stimulatory substances. These, too, get to the surface of the soil together with the rushing up water. The spotty indicators of the subsoil water are the spots of macrovegetation, as well. The vegetative spots of *Bolboschoenus maritimus* are called "mudstained" even today by old agriculturer labourers because here the boots can become wet or muddy even in a dry weather.

In the course of the present-day flood-prevention, the water rushing up in the area protected by the levees has been denominated in Hungarian "buzgár" (spouting flood). The discussed phenomena of water uprush are similar because the basin of the lake Fehér-tó at Kardoskút—Puszta-Centre had in times past been the bed of a primaeval river.

Fig. 6. Marshy water-uprush of bulging surface at the eastern end of the lake Fehér-tó. It was formed in Spring 1970, in the period of the Great Flood-Prevention in the Lower Tisza Region. The surface of crevasses is stained by algal mass-production.

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