Acta Biol. Szeged. 29 (1—4), pp. 101—116 (1983)

THE EFFECT OF PRECIPITATION MAXIMUMS ON THE SPECIES SYNTHESIS OF THE AGROPHYTOCENOSES OF THE SAND RIDGE BETWEEN THE DANUBE AND TISZA

GY. BODROGKÖZY

Department of Botany, Attila József University, Szeged
(Received September 15, 1982)

Abstract

The study was carried out in the Southern regions of the sand ridge between the Danube and Tisza of the Great Hungarian Plain in the years when the precipitation reached the maximum in June. On its effect inland waters developed for shorterlonger periods even in the sandy croplands. Due to this the original agrophytocenoses changed. During the course of evaluating the changes in their species synthesis 30 subunits were separated within 10 categories according to moisture demand. These values were compared with the data of the F and W values.

Correlation was found between certain Consolido-Eragrostion minoris and Tribulo-Eragrostion minoris associations and the range of their soil- and subtypes.

With the help of the vegetation map prepared in the area of the village Tázlár conclusions may be drawn regarding the various degrees of the danger of inland waters, which may also be useful in practice.
Key words: Hungary, sand ridge between the Danube and Tisza, agrophytocenoses, hydroecology.

Introduction

In the relations of the lowland, from the environmental-biological factors water has the most important effect on the species synthesis of the stands. This is valid both in the case of naturally occurring and agrophytocenoses. The sand areas between the Danube and Tisza proved especially suitable for studies in this concern, since these areas are of different relief and are characterized by various stands developing on the effect of inland waters following the precipitation maximums appearing in the beginning of Summer.

The question of classification according to the moisture demand of plant species has come into foreground of interest both in Hungary and abroad. The classification of the Hungarian flora according to species — taking as a base the system of ELLENBERG — was accomplished by SOÓ and published in six volumes (1964—1980), taking into consideration their temperature and nitrogen demands, too. This work was made more accurate by the T W and R scale of ZÓLYOMI and his co-workers (1966) comprising 1400 species. However, while the work of SOÓ uses the No. 5 scale system and the transitional units within this, supplemented with the O category unit, ZÓLYOMI et al. grouped the processed species into 11 categories. Here the O unit received another meaning, and the unit of the indifferent species was eliminated. The mathematical calculations in this regard were carried out by PRÉCSÉNYI.

For the further improvement of the classification of plant species according to water-demand the elaboration of the basis of such a hydroecological system became necessary, where three-three; that is a total of thirty subunits can be disintegrated within the ten categories. This, however, can only be accomplished if the H-curve of the

various species is also designed (BODROGKÖZY, 1982). With the use of these graphs their distribution according to the quota of their basal area within the different stands can also be determined.

Materials and Methods

The chosen area surveyed during the course of studying is situated in the Southern region of the sand ridges between the Danube and Tisza in the plain of Bócsa-Tázlár-Kiskunhalas (Fig 14). In this area of different relief the grass plants of the puszta covering the sand-hill systems (Festucion vaginatae) vary from hawthorn thickets to injured acacia groves. The tilling of arable land as well as grape-vine and fruit production are being carried out in the areas of more shelving relief. The meadow sand and moulding mud soil of the flat lands range from marsh meadow associations to saline plains having szoloncsák and szloncsák-szolonyec soil, respectively.

In this paper, fisrstly the questions related to the culture cenoses developing on the various soil sypes, and the classification of their species components according to moisture demand will be discusted. Furthermore, a report is given on the possibilities of applying supplementary methods related to the determination of their water demand.

The elaboration from a similar viewpoint of the sandy plain stand was carried out near Szeged, in the Nature Conservation Area of Ásotthalom (BODROGKÖZY, 1982).

During the procession of the data originating from the various culture cenoses not receiving weedicide, each species component's graph was prepared reflecting their hydroecological demand (hereinafter H). On the graph, the closer the minimum values get to each other, the higher the percentage of the culmination point is. Generally the species reaching a maximum value of 50% or more have a restricted H-amplitude. Thus, from this viewpoint these can be considered as the H-characteristic species components of the various phytocenoses, and conversely (Fig. 1).

For the purpose of comparison the F (ELLENBERG, Soó system) and W numbers (ZÓLYOMI et al. 1966) were also given in the tables of the different agrophytocenoses in case of the species belonging to the various H-categories. Their comparison is made difficult because of the varying scale-grades, nevertheless, it could be determined that despite the evaluations carried out with different methods their classification coincides. Differences appeared in the case of the species with wider H-compyling capacity (BODROGKÖZY, 1982). — The classification of 10 H-categories elaborated by the author wished to serve as a further improvement, within which 30 subunits were separated with the help of the H-curves to demonstrate the borderlines between the different categories. No. 1 indicates a transition towards a damper neighbouring category, No. 3 indicates that of a drier neighbouring category, while No. 2 gives an indication of the type (Table 1., Figs. 3, 6).

The natural features of the studied area are suitable for the congregation of inland waters developing quite frequently in places on the effect of precipitation maximums in the beginning of Summer in Hungary. Later, depending on their duration, smallerlarger qualitative or quantitative changes occur in the species composition of the various culture phytocenoses on these areas of deeper relief.

Cenosystem of the stands

During the systematization ol the processed associations and their smaller units, resp., besides the agrophytocenoses the associations referred to are listed, in an unusual manner.

CHENOPODIO-SCLERANTHEA

Secalietea

Eragrostetalia

Tribulo-Eragrostion minoris

1. *Vicio-Polygonetum arenarii* TIM. 57.
2. *Tribulo-Tragetum* SOÓ et TIM. 54.
3. *Vicio-Eragrostietum minoris* TIM. 57.
4. *Digitario-Portulacetum* (Felf. 42) TIM. et BODRK. 55.
5. *Portulaco-Chenopodietum* (n. nov.)
6. *Hibisco-Eragrostietum minoris* SOÓ et TIM. (51) 57.

Consolido-Eragrostion minoris
7. *Amarantho — Chenopodietum albi* (MORARIU 43) Soó 53

Bidentetea tripartitae
Bidentetalia
Chenopodion rubri
8. *Lythro — hissopifoliae — Gnaphalietum luteo-albi* (BODRK. 48) PIETSCH 64

PUCCINELLIO-SALICORNEA
Festuco-Puccinellietea
Puccinellietalia
Juncion gerardii
9. *Agrostio-Caricetum distantis* (RAPCS. 27) Soó 30

Results and discussion

The following culture cenoses were processed, starting from the higher relief conditions, taking into consideration their changes in succession (Fig. 13):

1. *Vicio — Polygonetum arenarii*

These are Autumn spiked cultures with loose, lime carbonate quick-ground, they are firstly the weed association of rye-sowings since other spiked species can only rarely be grown profitably in its site.

This humus-poor, chalky, loose sand-drift becomes reorganized frequently in the Summer draughty period, on the effect of which the formed organic matter becomes oxidized rapidly and so only 0.5 % can be demonstrated in the rooting zone. The washable anount of the soil physical fraction is extremely low.

Its moisture supply is only satisfactory in the aspects of Spring, early Summer and late Autumn. The precipitation maximum developing at times in June may favourably influence the qualitative and quantitative constitution of the certain cenoses, nevertheless, the species needing moisture do not find their conditions for life. From their character species, the denominating *Polygonum arenarium, Vicia villosa* and

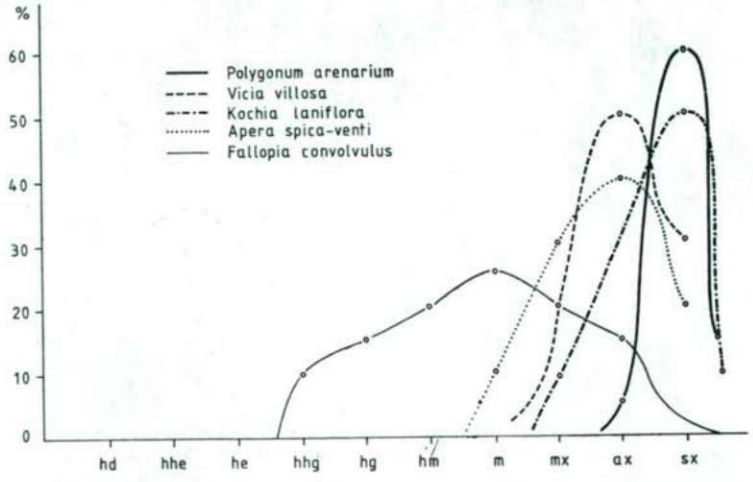


Fig. 1. H-curves of the species components of loose quick ground Autumn spiked cultures.

Kochia laniflora have H-curves where the maximum is over 50% or at least reaches this value; therefore these can be regarded as species having restricted H-amplitude. On the basis of their total covering quota the *sx 3* — species showed by far outstanding values (Fig. 3).

Earlier, in the arable, grape-vine and fruit cultures left out of the cultivation periodically, the succession of reestablishment of the plain vegetations was observable in the period without cultivation, depending on its duration. In such a way the primary sandy grassland shows a development from *Brometum tectorum* towards *Festucetum vaginatae danubiale*. Here, too, as in the other sandy plain areas of the lowland, the poineer species is the extremely compliant *Erigeron canadensis*, until it preserves its competitiveness; and its association with the *Ambrosia elatior* has been observed recently. These were later followed by the *Euphorbia seguieriana, Centaurea arenaria* ssp. *tauscheri*. From the aspect of the stubble-field the *Vicio-Polygonetum arenarii* showed a transition towards the following row crop weed association.

2. *Tribulo — Tragetum*

This is the weed association of loose, chalky quick ground row crop cultures. Since in this site most of the row crop cultures cannot always be cultivated profitably, the grape-vine cultures giving the best wine grown on sandy soil were established here. Its nutriment and water supply is partially similar to that of the afore-mentioned spiked cultures. The fact, however, that the vegetative period of these row crop weed cenoses falls to the Summer draughty period causes significant changes. Accordingly, apart from the increased insolation these species components also have to stand the almost unbearable degree of warming up of the soil surface as well as the damaging effect of this. The unfavourable site conditions can be decreased by intensive organic matter replacement and watering, resp. The H-relations are essentially more extreme than those of the spiked crops having similar site conditions. The higher H-culmina-

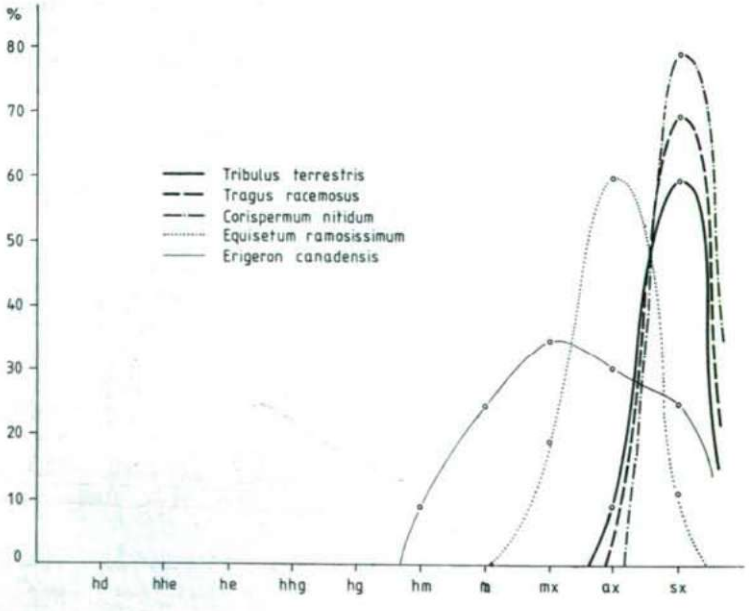


Fig. 2. H-graph of *Tribulo-Tragetum* species.

tive point of certain species can be explained by this. Thus, for example, that of the *Corispermum nitidum* may even reach the value of 80%. This is followed by the *Tragus racemosus* and the *Tribulus terrestris*. Their further data are shown on Fig. 2.

Comparing the covering quota of the *Tribulo-Tragetum* species and the spiked cultures, major difference could not be demonstrated within the H-categories. The *sx 3* is also outstanding in this case (Fig. 3). However, while the majority of the occurring

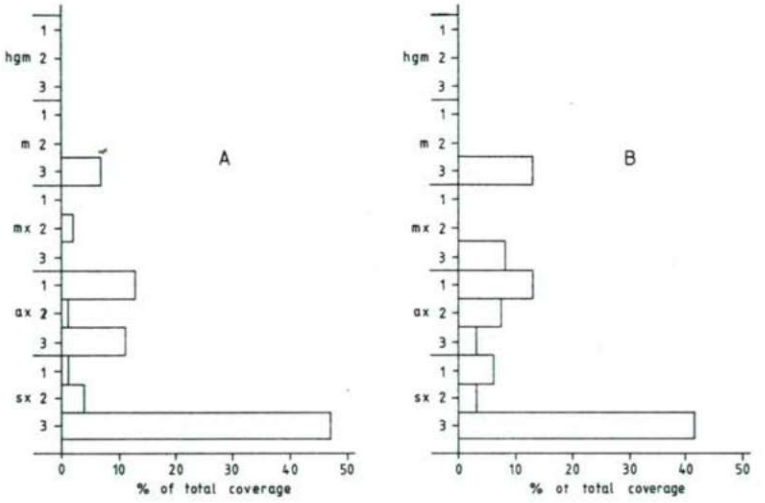


Fig. 3. Comparative graphs of the total covering values of the *Vicio-Polygonetum arenarii* (A) and *Tribulo-Tragetum* species, (B) within H-category subunits.

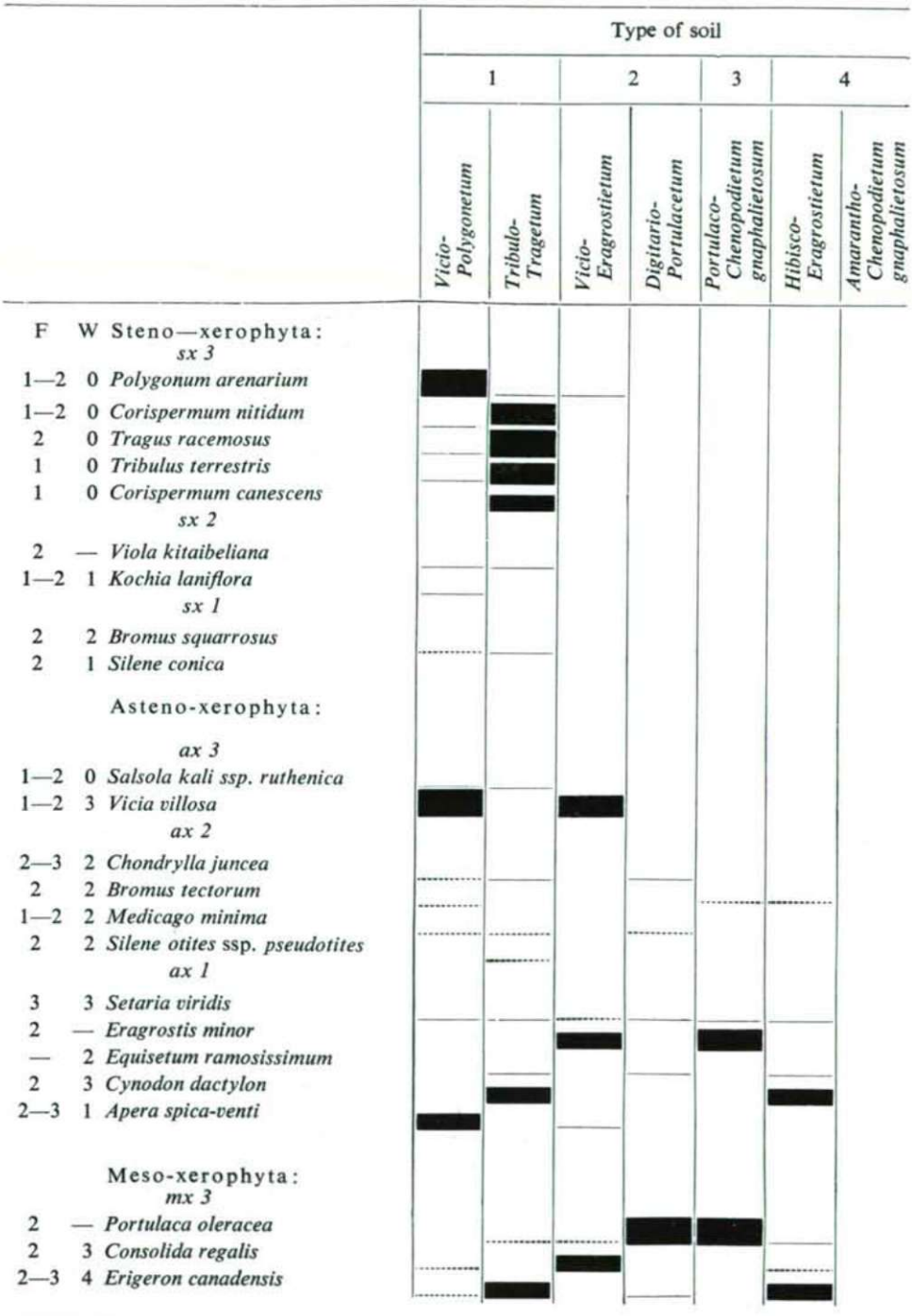
weed species belongs to one of the subunits of the *ax* and *sx* H-categories, the significant covering quota is striking in the case of certain *m 3* species having wide H-ecological compliance. Examples of this are the *Chenopodium album* and the *Fallopia convolvulus* (Table 1, Fig. 3). The appearance of *Portulaca oleracea* subass is of transitional character (Table 1).

3. *Vicio-Eragrostietum minoris*

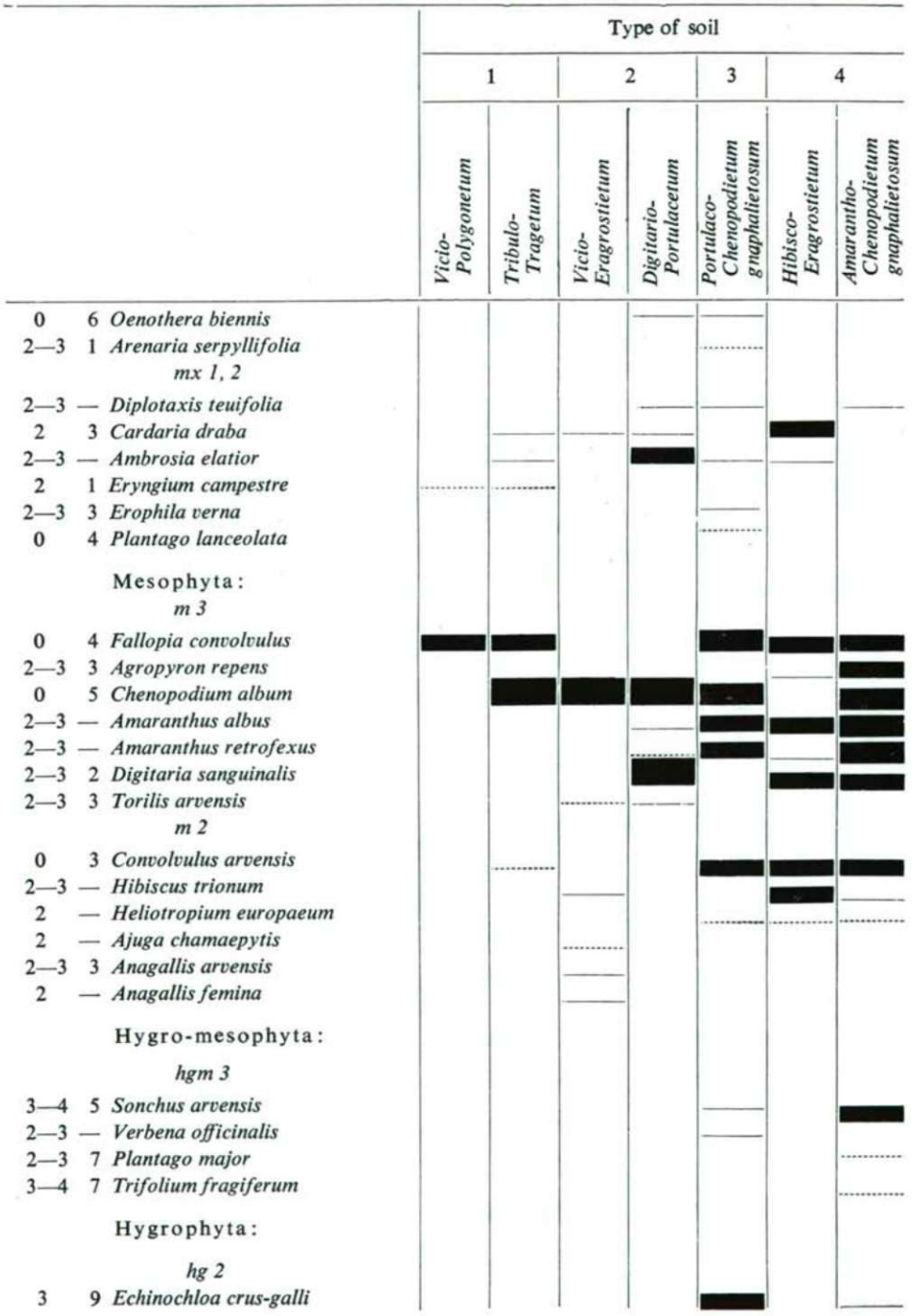
The spiked cultures with soil of harder lime carbonate and humous quick ground belong to this association. Their soil profile is homogeneous. Since the Summer reestablishment of the soil does not take place, there is a possibility for soil development. This is mainly manifested in the accumulation of the organic matter content. Its amount, however, does not reach 1% even near the surface. Its water-binding capacity is favourably influenced by the increasing amount of the washable fraction. The low soil-stagnant water content means an advantage for its stand.

Analysis of its species composition showed that the dominating components have essentially wider H-compliance than the previous two associations. According to this, the culminative point of their H-curve does not reach the value of 50%. The only exception was the *Vicia villosa*. The widest H-amplitude was that of the *Consolida regalis: ax3, mx3, 2* (Fig. 4).

Table 1. Distribution according to water demand of the species components of field crop associations in the study area



F	W	Steno—xerophyta:
		sx 3
1—2	0	*Polygonum arenarium*
1—2	0	*Corispermum nitidum*
2	0	*Tragus racemosus*
1	0	*Tribulus terrestris*
1	0	*Corispermum canescens*
		sx 2
2	—	*Viola kitaibeliana*
1—2	1	*Kochia laniflora*
		sx 1
2	2	*Bromus squarrosus*
2	1	*Silene conica*
		Asteno-xerophyta:
		ax 3
1—2	0	*Salsola kali ssp. ruthenica*
1—2	3	*Vicia villosa*
		ax 2
2—3	2	*Chondrylla juncea*
2	2	*Bromus tectorum*
1—2	2	*Medicago minima*
2	2	*Silene otites* ssp. *pseudotites*
		ax 1
3	3	*Setaria viridis*
2	—	*Eragrostis minor*
—	2	*Equisetum ramosissimum*
2	3	*Cynodon dactylon*
2—3	1	*Apera spica-venti*
		Meso-xerophyta:
		mx 3
2	—	*Portulaca oleracea*
2	3	*Consolida regalis*
2—3	4	*Erigeron canadensis*


Type of soil
1
2
3
4
Vicio-Polygonetum
Tribulo-Tragetum
Vicio-Eragrostietum
Digitario-Portulacetum
Portulaco-Chenopodietum gnaphalietosum
Hibisco-Eragrostietum
Amarantho-Chenopodietum gnaphalietosum
0 6 Oenothera biennis
2—3 1 Arenaria serpyllifolia
mx 1, 2
2—3 — Diplotaxis teuifolia
2 3 Cardaria draba
2—3 — Ambrosia elatior
2 1 Eryngium campestre
2—3 3 Erophila verna
0 4 Plantago lanceolata
Mesophyta:
m 3
0 4 Fallopia convolvulus
2—3 3 Agropyron repens
0 5 Chenopodium album
2—3 — Amaranthus albus
2—3 — Amaranthus retrofexus
2—3 2 Digitaria sanguinalis
2—3 3 Torilis arvensis
m 2
0 3 Convolvulus arvensis
2—3 — Hibiscus trionum
2 — Heliotropium europaeum
2 — Ajuga chamaepytis
2—3 3 Anagallis arvensis
2 — Anagallis femina
Hygro-mesophyta:
hgm 3
3—4 5 Sonchus arvensis
2—3 — Verbena officinalis
2—3 7 Plantago major
3—4 7 Trifolium fragiferum
Hygrophyta:
hg 2
3 9 Echinochloa crus-galli

			Type of soil						
			1		2		3	4	
			Vicio-Polygonetum	*Tribulo-Tragetum*	*Vicio-Eragrostietum*	*Digitario-Portulacetum*	*Portulaco-Chenopodietum gnaphalietosum*	*Hibisco-Eragrostietum*	*Amarantho-Chenopodietum gnaphalietosum*
4—5	8	*Ranunculus repens*							
3—4	6	*Potentilla reptans*							
		hg 1							
2—3	7	*Linum catharticum*							
4	9	*Chlorocyperus glomeratus*							
4	6	*Tetragonolobus maritimus*							
4	8	*Mentha pulegium*							
		Helo-hygrophyta:							
		hhg 3							
3—4	—	*Gnaphalium luteo-album*							
3	8	*Agrostis stolonifera*							
4	7	*Blackstonia acuminata*							
3	7	*Achillea asplenifolia*							
4	8	*Pycreus flavescens*							
3—4	9	*Bidens tripartita*							
4—5	9	*Lycopus europaeus*							
		hhg 2							
4	10	*Cyperus fuscus*							
4—5	7	*Potentilla anserina*							
3	8	*Centaurium vulgare* ssp. *uliginosum*							
		hhg 1							
4	10	*Juncus articulatus*							
4—5	10	*Eleocharis palustris*							
		Helophyta:							
		he 3, 2							
4—5	9	*Mentha aquatica*							
4	9	*Teucrium scordium*							

The species distribution according to the various H-categories and their situation within the association, resp. can be evaluated on the basis of their covering quota. According to this, here the transitional *ax 1* as well as the species belonging to the *mx*

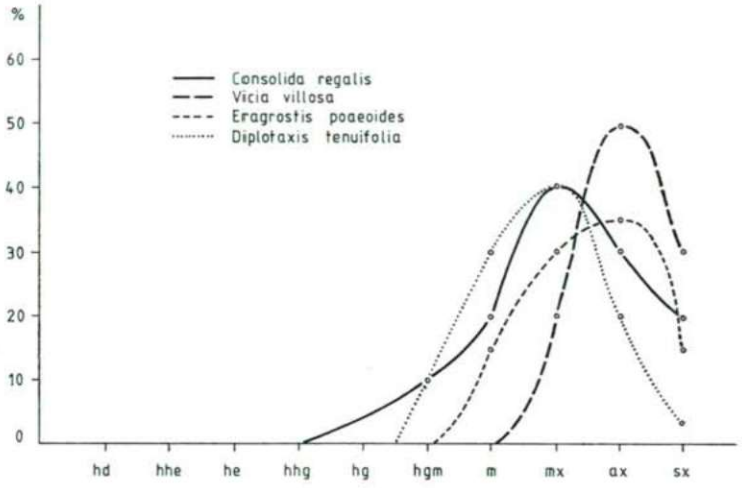


Fig. 4. H-curves of hard quick ground spiked species.

cultures (although giving wine of poorer quality) and orchards — firstly peacheries and *m* categories play the leading role, and not the *sx*.

From the *mx* and *m* categories the transitional-type *m 3 Agropyron repens* became prevalent. Further details can be seen on Table 1 and Fig. 6.

4. *Digitario-Portulacetum*

This association is made up of hard lime carbonate quick ground Autumn spiked areas, mainly row crop weed cenoses developed in the areas of row crops. It gives large crops and is also the characteristic weed cenosis of the regularly cultivated grape-vine and apple cultures (BODROGKÖZY, 1958, 1959).

Regarding the affiliation within the H-categories of the various species components it could be determined that the dominating species are those having wider H-ecological compliance. Accordingly, the maximum value of their H-curve did not rise above 40%. By now the amount of the mesophyton representatives is significant (Fig. 5).

During the course of analysing their total covering quota it was demonstrable that compared to the previous weed ceoan cenosis the percentage value of the *m 2* members decreased to the advantage of the *m 3* representatives. This was firstly due to the values of the *Digitaria sanguinalis* and the *Agropyron repens,* reaching high covering values during the late Summer.

Within the *mx*-category, an outstanding value was shown by the *Portulaca oleracea* beloing to *mx 3,* also becoming prevalent by the end of Summer (Fig. 6). Besides this, the also continuously regerminating *Ambrosia elatior* of the *m 2* group may have a role, but only if certain weedings are left out.

In the case when due to some kind of cause the arable-, grape-vine- or orchard cultures are not cultivated — which was mainly observable in the previous period —

transitionally the dense stands of *Erigeron canadensis* and *Ambrosia elatior* appear for the period of a few years, suppressing the rest of the weed species. Nevertheless, in the Spring aspect the yellow carpet-bed of *Senecio vernalis* covers these areas.

In the study area the hard quick grand spiked and row crop cultures can still be found between such high relief conditions that they do not always fall under the effect of the overflows in the years when inland waters occur. Therefore hygro- and helo-hygrophyton representatives do not appear among their species components.

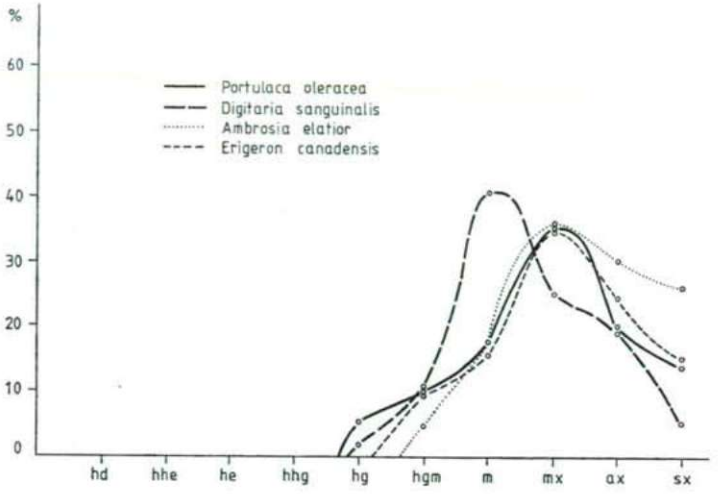


Fig. 5. Graph of H-characteristic species of the *Digitario-Portulacetum*.

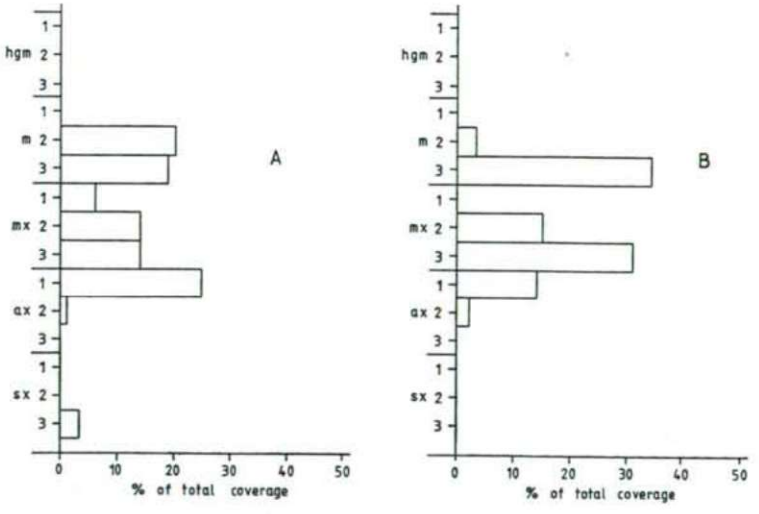


Fig. 6. Comparative graphs of the total covering quota of the *Vicio-Eragrostietum minoris* (A) and *Digitario-Portulacetum* species (B).

5. *Portulaco-Chemopodietum albi gnaphalietosum*

These are firstly the culture cenoses of the humous sandy soil row crop cultures; potato, maize, sunflower, but also of paprika. The organic matter content of their soil is between 1.5—2%, depending on the nutriment supply. In regard of its granule composition the washable fraction became the double compared to the previous one. As the consequence of the changed site conditions species of higher standard also enter into their cenoses without a change in the dominating role of *Portulaca oleracea.* Such species are the *Chenopodium album, Amaranthus albus, A. retroflexus, Fallopia convolvulus,* belonging to the *m 3* group (Fig. 7).

In respect of their covering quota the species of *mx 3* and *m 3* reached outstanding values (Fig. 9).

Following the development of precipitation maximum in the beginning of the Summer the gathered inland waters in this zone affect the stands of *Portulaco-Chenopodietum* only for a short time. Neither the culture vegetation, nor the weed species suffer damage on its effect. However, in the second half of the Summer certain helo-phyton representatives, mainly the *Gnaphalium luteo-album, Pycreus flavescens* and possibly the *Cyperus fuscus* may have a role individually or with low covering quota in the lower relief zones of these humous sandy row crop cultures. Despite the fact the culminative points of the H-curves of these mud plant species vary between the values of 50—70% in the *hhg* category, they also find conditions for life between the *hgm* conditions. This is particularly valid in the case of *Gnaphalium luteo-album* (Fig. 7).

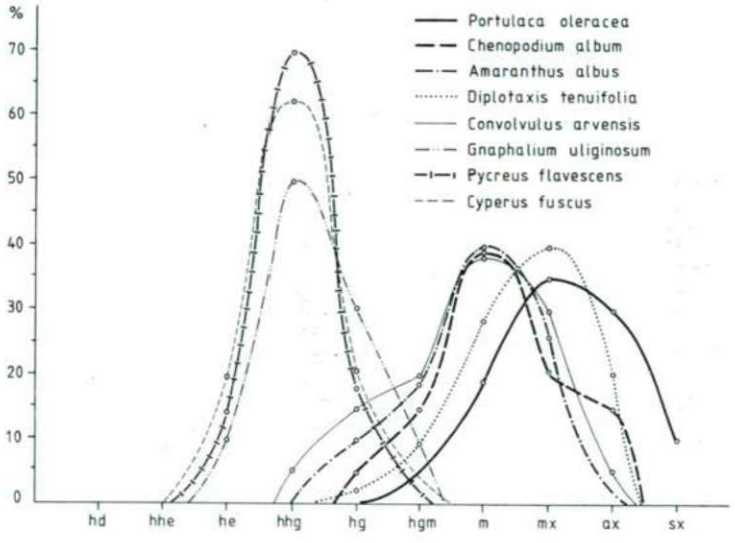


Fig. 7. Comparative H-curves of the *Portulaco-Chenopodietum albi gnaphalietosum* species.

6. *Hibisco — Eragrostietum minoris*

In the study area, and also in other regions of the country, this is the weed association of the chernozem-type sand as well as the chernozem-soiled Autumm spiked cultures. The stands are formed by frequent species germinating in Autumn and gi-

ving crops during the course of the Summer. These species also have wide H-compliance. The maximum points of their H-curve are mostly under the value of 40%. They reach the total covering maximum in the aspect of the stubble-field, when a transition occurs towards the row crop weed associations developing under similar site conditions (Fig. 9). At times of inland waters they may be covered by these waters for shorter-longer period in the areas of deeper relief, mainly in the aspect of the stubble-field. If this phenomenon is only of short duration the subassociation described in the case of *Portulaco-Chenopodietum albi* may develop.

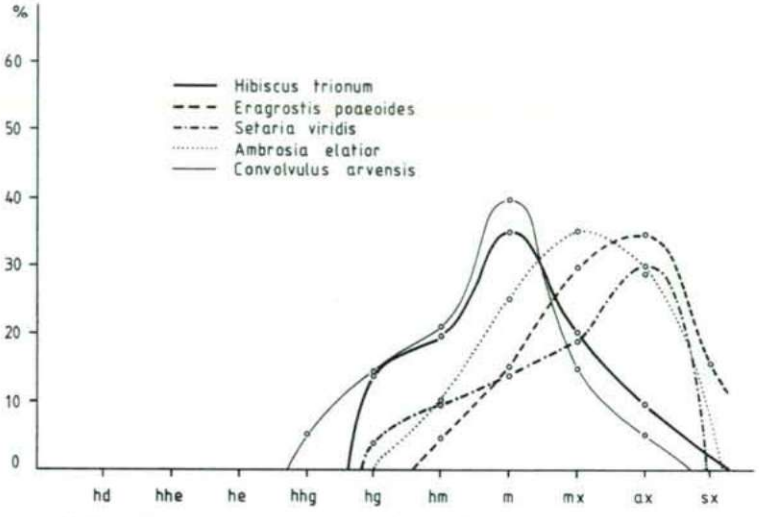


Fig. 8. H-curves of the *Hibisco-Eragrostietum minoris* species.

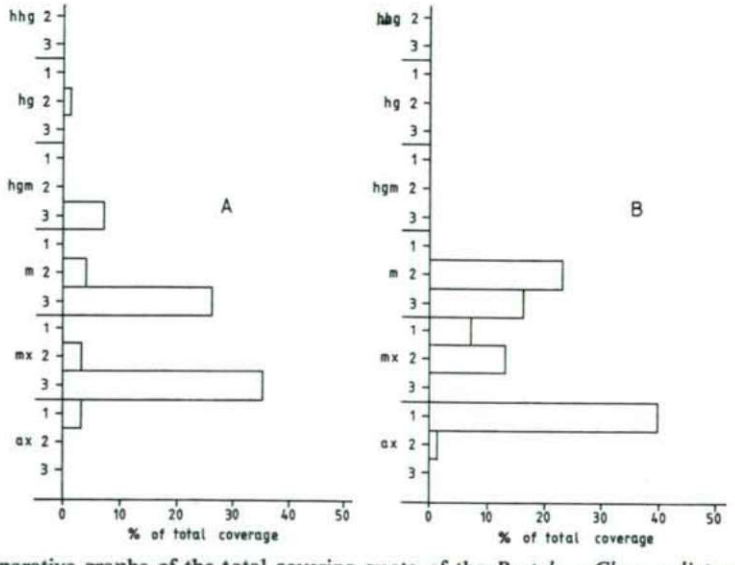


Fig. 9. Comparative graphs of the total covering quota of the *Portulaco-Chenopodietum gnaphalietosum* (A) and *Hibisco-Eragrostietum* species, (B), within the H-categories.

7. *Amarantho-Chenopodietum albi gnaphalietosum*

In the study area it is of subordinate position; just like in the case of it's spiked partners it regularly occurs in the harder meadow-like sand of chernozem character and in the chernozem soils, resp. Accordingly it forms the culture cenoses of potato, maize and cattle-turnip. It is one of the most wide-spread arable soil and garden weed cenoses all over the country.

Regarding its situation it forms the deepest relief zone here. Therefore this area is exposed to the effects of inland waters in a greater extent. From hydroecological point of view, contrary to the species components of the *Hibisco-Eragrostietum minoris,* here the H-characterized members belong to the *m*-category. Accordingly the *Amaranthus albus, A. retroflexus, Agropyron repens, Chenopodium album,* etc. can be regarded as *m 3* representatives. Their total covering quota is also expressedly high (Fig. 11).

In periods of inland waters the largest amount of helohygrophyta was detectable in this area, but helophytons also entered the cenoses individually, as the *Mentha aquatica, Teucrium scordium.* From these the *hhg 2 Cyperus fuscus* and *Potentilla anserina* appeared as a subassociation besides the denominating *Gnaphalium luteo-albun* (Fig. 10).

8. *Lythro hyssopifoliae — Gnaphalietum luteo-albi gnaphalietosum* (=typicum)

In the case when in the period of inland waters the spiked and row crop cultures of the deeply-situated soils are durably covered by water, both the culture and weed species die out. Plough-land mud vegetation develops in their place. Although it is in tight relationship with the mud vegetation found along the river, the *Cypero-Juncetum,* it can well be distinguished from that (BODROGKÖZY, 1958; PIETSCH, 1965, 1973).

Regarding its sire conditions its soil is watering character. Since the gathered rainwater washes together a large amount of colloid fraction from the neighbouring areas, the mud fraction is prevalent. During the process of drying out, mosaic-like crackings are formed on the surface.

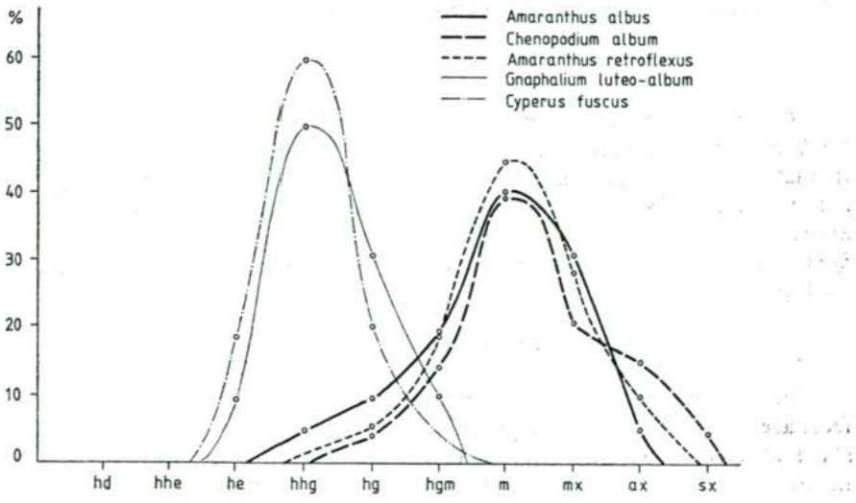


Fig. 10. Graph of the weed association species of damp-typed hard soiled spiked cultures. Evaluations are according to the H-categories.

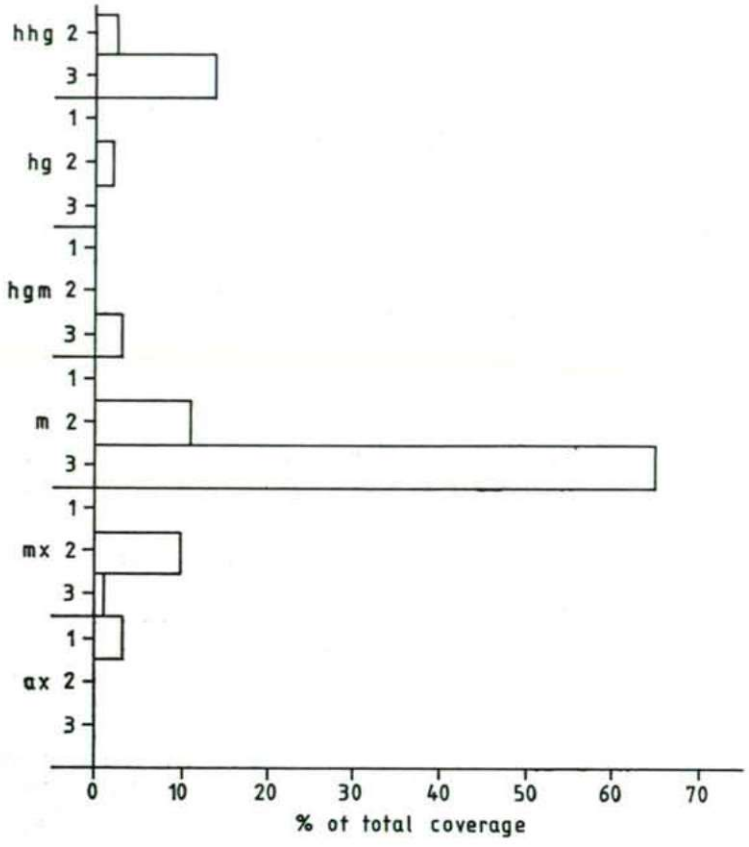
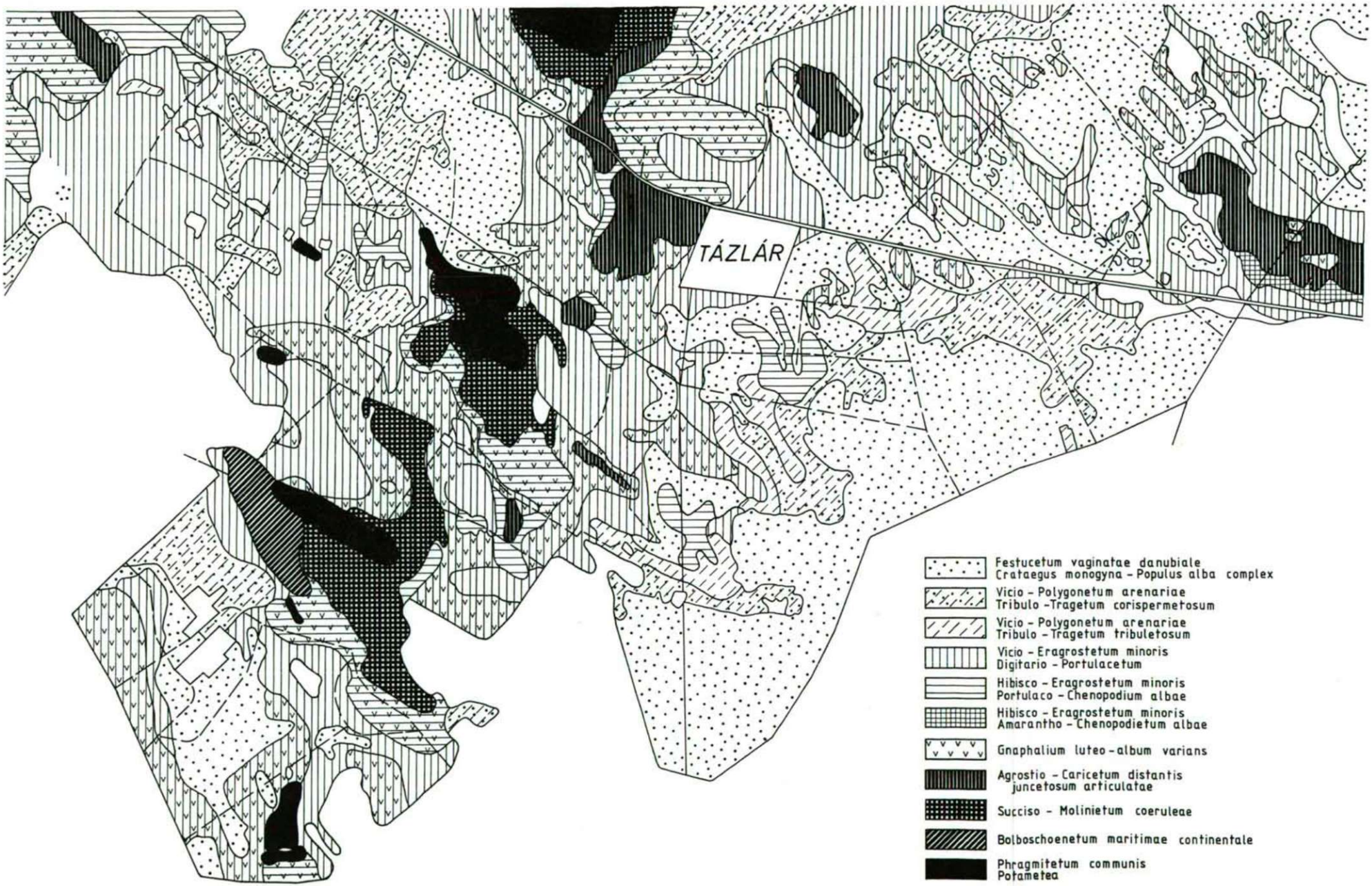


Fig. 11. Graph showing the distribution of *Amarantho-Chenopodietum gnaphalietosum* according to the total covering quota, within the H-categories.

Among the species components, the helo-hygrophytons are dominating; mainly the *hhg 2*-type *Gnaphalium luteo-album, Cyperus fuscus* and the *Pycreus flavescens*. In this latter case the culminative point of the H-curve is especially high. The *Enhinochloa crus-galli* of *hg 2* has a significant covering quota. Though it is firstly the species appearing in masses in rice fields, due to its wide H-compliance, it may also occur in the *hgm*-category as well as in the *m*-category as garden weed. Further details are given on Fig. 12.

9. *Agrostio-Caricetum distantis juncetosum articulatae*

In the areas where there are permanent inland waters and the agrotechnical effects are missing for a longer period, a more competetive perennial marsh-vegetation starts to develop. As pioneers, the characteristic representatives of the Agropyro-Rumicion crispi begin to expand, firstly the *Agrostis stolonifera* and the *Potentilla anserina, P. reptans, Trifolium fragiferum*. The appearance of *Carex distans* is followed by the *Juncus articulatus Carex serotina*, which can be held as a differential species.



Vegetation map of the area of Tázlár village, showing the conditions of extreme inland water periods when certain stands of the *Digitario-Portulacetum* were also flooded.

It has slightly szoloncsak meadow sand soil. The explored soil segment is uniform grayish-brown muddy sand till 55 cm, which means the genetic A-level. The lower B-level is made up of whitish light-grey lime carbonate sand, with occasional dark mud streaks. In the lower layer the accumulation of total salts can be demonstrated, in an amount surpassing the lowest point of the saline degree (0.015 %). This explains the appearance of *Plantago maritima, Taraxacum bessarabicum, Lotus tenuis* among the species components, which are otherwise also characteristic of *Agrostio-Caricetum.*

If these watery areas are drained, they gradually dry up and the previous species being more and more at a disadvantage are replaced by *Festuca pseudovina, Cynodon*

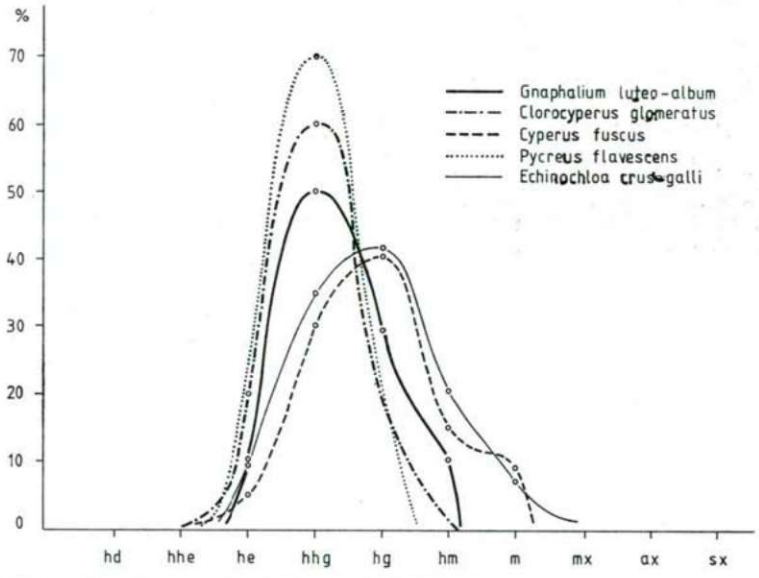


Fig. 12. H-curves of the species components of mud vegetation.

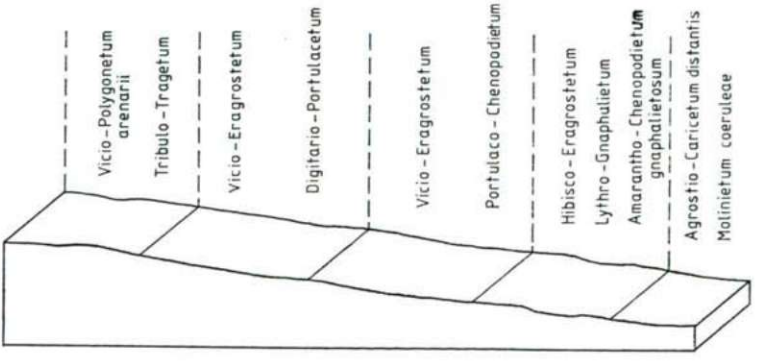


Fig. 13. Zonation system of the culture phytocenoses occurring in the studied areas, on the basis of the different reliefs.

dactylon, Cichorium inthybus, Scorzonera cana. If it is further dispensed from the devasting effect, then gradually the variant of *Potentillo arenariae — Festucetum pseudovinae Plantago maritima* may develop.

References

BODROGKÖZY, Gy. (1958): Beiträge zur Kenntnis der synökologischen Verhältnisse der Schlammvegetation auf Kultur- und Halbkultur Sandbodengebieten. — Acta Biol. Szeged. *4*, 121—142.

BODROGKÖZY, Gy. (1958b): Die Kartierung der Sandgebiet des Tisza-zug nach Weinbau Standorttypen. — Acta Agr. Acad. Sci. Hung. *8*, 31—57.

BODROGKÖZY, Gy. (1959): Adatok a délkelet-kiskunsági homoki szőlők gyomtársulásainak ismeretéhez (Beiträge zur Kenntnis der Unkrautassociationen in den Weingärten auf Sandböden im südlichen Teile des Kiskunság). — Bot. Közlem. 81—94.

BODROGKÖZY, Gy. (1982): Hydroecology of the vegetation of sand forest-steppe character in the Emlékerdő at Ásotthalom (S. Hungary). — Acta Biol. Szeged. *28*, 13—39.

PIETSCH, W. (1965): Beiträge zur Gliederung der europäischen Zwergbinsen-Gesellschaften. — Vegetatio *13*, 1—37.

PIETSCH, W. (1973): Zur soziologie und ökologie der Zwergbinsen-Gesellschaften Ungarns (Klasse Isoeto-Nanojuncetea BR-BL. et Tx 1943). — Acta Bot. Acad. Sci. Hung. *19*, 269—288.

SOÓ, R. (1964—1980): A magyr flóra és vegetáció rendszertani-növényföldrajzi kézikönyve I—VI (Synopsis systematico-geobotaniea florae vegetationisque Hungariae I—VI). — Budapest.

TIMÁR, L. und BODROGKÖZY, Gy. (1969): Die pflanzengeographische Karte von Tiszazug. — Acta Bot. Acad. Sci. Hung. *5*, 203—232.

ZÓLYOMI et *al.* (1966): Einreichung von 1400 Arten der ungarischen Flora in ökologische Gruppe nach TWR-Zahlen. — Fragm. Bot. *4*, 102—142.

Address of the author:
DR. GY. BODROGKÖZY
Department of Botany, A. J. University
H-6701 Szeged, P.O. Box 428
Hungary