The terminology of the geo-aeolian environment

especially in relation to Danish landscapes

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Abstract

Localities with aeolian materials are classified, tentatively on three independent basic principles: 1) dynamic, 2) sedimental, 3) geometric (morphometric). The nominated terms are arranged in a table (II) in order to suggest a system of aeolian geo-environments.

Introduction

Excellent reviews of the geomorphology of Danish landscapes influenced by the wind have been worked out by *Warming* 1907-1909, *A. Schou* 1945, 1949 and *Niels Nielsen & Schou* 1958. However, an attempt of composing a consistent terminology for the geo-aeolian environments in Denmark makes it desirable to link these works together with the newest studies of sand drifting and dunes (*Bagnold* 1954, *Sindowski* 1956, *Cooper* 1958, *Kuhlman 1958* and *Finkel* 1959). The attempt below does not pretend to be exhaustive; it only tends to outline the fundamental features in a »natural system«.

For a geomorphological classification different points of view may be adopted: 1): dynamic; 2): sedimentological; 3): form-descriptive; 4): evolutionistic. A distinction between these four categories is normally not maintained; however, elements from all of them contribute to the explanatory description of the landscapes. The common descriptions bear the stamp of *W. M. Davis'* ideas of the natural evolution of the landscape; these sometimes imply pseudo-explanations and uncertain hypotheses. Therefore, some modern geomorphologists maintain an attitude of reserve towards *Davis'* evolutionistic points of view, which may involve scientific pitfalls. In Scandinavia *Behrens* has recommended to adopt a clear distinction between morphologic description and genesis; this will make it easier to arrive at scientific explanations, which to-day are further facilitated because exact observations and experiments are gaining foothold in the geomorphological methodology. Especially the studies of dunes and of wind-erosion have profited from the quantitative measurements, without which it is impossible to elaborate a valid systematism. A form description will be systematic, when it is based both on the geometrical figurations and on their »ontogeny« and »phylogeny«. The development of the form-shaping processes may be called the geomorphological ontogeny, the basis of the dynamical classification. The descent of the forms is the morphologic phylogeny. Pure descriptions are rare in the dune topography, and often they have a curious »two-dimensional« character, for instance: »white dune« and »grey dune«.

In the following the landscape influenced by the wind is treated on the basis of the above-mentioned principles.

History

Since the works of *Sokolow* 1884 and *Steenstrup* 1894 appeared many geo-aeolian papers have been published, among which the present text only refers to those which have dominated the treatment of this subject in Denmark and which are the origin of our modern theories. *E. Warming* 1907-1909 in his monography of the vegetation on Danish dunes gave a comprehensive review of dune forms and of their birth; his work authorized the opinion that the most important aeolian sedimentation in a humid climate is the result of an interaction between vegetation and sand drifting; this has also been mentioned by ancient authors: *Viborg* 1788, *Groos* 1847, and *Andresen* 1861; however, Warming brought us the understanding of the biology and of the morphological effect of the dune vegetation. He introduced terms which became classic, for instance »white dune« and »grey dune«, »grønning« (= green dune valley), see *Lemberg, Schou, Kihlström;* these terms referred to the plant communities and not unambiguously to the geomorphology — a fact which at times has been overlooked by the posterity. From Warming a clue leads to *J. W. van Dieren,* whose book from 1934 brought a culmination of the research line of a botanical character, originating in the combating of the anthropogeneous sand drifting in Europe in the sixteenth to the eighteenth centuries; see *Wessely* 1873, *Gerhardt* 1900 and *Braun* 1911. The results cristallized in *v. Dieren's* work had been anticipated by many authors, see *Lemberg* and *Behrmann.* The dunes of North-West Europe and their plant communities have had correlative evolutions. Possessing this knowledge, *v. Dieren* established a systematism, including a latin terminology. The following dune evolution was fundamental: embryonal dunes (tussock dunes) — bank of dune sand with Ammophila — blow-outs — parabolic dune — secondary barchan . According to *v. Dieren* this sequence is due to self-degeneration of the vegetation. Such a pessimistic opinion is open to discussion, see *Cooper* 1958; however, it is not to be doubted that the said development has taken place in Europe and in the United States: *Paul* 1944, *V. Hansen* 1957 and *Hack* 1941, *Hefley & Sidwell* 1945. Van Dieren introduced a clear distinction between »physical« dunes and »organic« dunes (p. 204-207); in the United States »organic« has been replaced by »phytogenic« *(Smith, Cooper)*. More particularly a distinction is made between desert dunes and coastal dunes, see *Schou* 1945, p. 148; this distinction is critizised by *Cooper* 1958, p. 66-68. The present-day standpoint must be that *v. Dieren's* classification is misleading, because gradual transitions are seen between »phytogenic« and »physical« dunes, and because the forms in arid zones and in humid zones may be explained by the same »natural laws« as those formulated by *R. A. Bagnold* 1935-1954.

Bagnold, whose works are epoch-making, introduced the modern aerodynamics in the dune morphology; his results have been confirmed by *Chepil* and *Zingg*. On a number of points *Bagnold's* studies open a new »era«; here are only mentioned the most relevant. He demonstrated that the sand drifting is caused by the saltation of the grains and by the resulting surface-creeping, the so-called »reptation«. The movement which takes place across loose sand creates wind ripples, which mark the most frequent points of impact of the saltation grains. *Bagnold's* explanation of the occurrence of the ephemeral wind ripples (see also *Trikalinos* 1928) has encountered difficulties in chasing wrong interpretations, especially the »Helmholtz theory«, which came to life because *Baschin* considered cirrocumulus to be homologous with wind ripples; other »wave-theories« too have ravaged the dune morphology, see *Exner*. *Bagnold* has given a mathematical expression of the relation between wind, sand and transport quantities. He further demonstrated that it is the wind force in the air layers next to the surface which influences the aeolian deposition and erosion; example: mobile sand sheets in relation to fixed, smooth surfaces are sheltered; i.e. the wind velocity at the same level is reduced. Consequently, a sand spot in a smooth environment will »catch« more sand. This phenomenon has been called by *H. T. U. Smith* 1953: psammogenic dune genesis, which explains the growth of many dune forms. In a Western European dune environment *Sindowski* and, later, the author have verified some of *Bagnold's* theories; it appeared that the aeolian transport and the dune genesis here are not essentially different from the conditions in an arid region; however, certain corrections had to be made of the formulae, see *Kuhlman* 1958. *W. Walther* has also worked in such terrains; however, with other theories as a point of departure. The most astonishing factor in relation to sand drifting in our climate is the feeble restraining effect exercised by rain and humidity. *Bagnold* has but a small influence on the recent morphological principal works, which are important by virtue of the amounts of their observations: *Paul* 1944, *Schou* 1945, *Melton* 1941 (a systematism) and *Cooper* 1958, whereas *Landsberg* 1956 and *Finkel* 1959 have probably initiated a new era of the aeolian geomorphology; their papers contain a lot of quantitative observations and mathematical models; the pronounced approach to the pure science will be the characteristic of the future geomorphology, which, otherwise, was bound to stagnate.

The status of the dune terminology

The modern dune literature (after 1930) has partly standardized certain dune types, the terms of which may change, whereas their identity is unmistakable. Among these, the most common are repeated here and commented on the basis of the most recent ideas. *Barchan* (Dunus falcatus, *v. Dieren)* is a bounded accumulation of blown sand of a well-known aspect: crescent-shaped ground-plan, triangular cross-section with angles of about 10°-140°-30°, the greatest of which at the dune crest. Less known are the genetic demands of the barchan: an immobile, even substratum, which by means of the psammo-genesis transforms into dunes the moderate sand quantities (per area) which blow from an almost constant direction. The nominal form is known from arid deserts, for instance Peru and Libya; in humid regions homologous forms are seen, partly ephemeral, small beach-forms, partly stable, atypical macro-forms: secondary barchans; German: Wanderdüne; Danish: mile *(Kuhlman* 1960). *Transverse dunes* (transverse ridges, *Cooper,* some Dunus anticus, *v. Dieren)* are big sand masses modelled in dense, interfering, barchanoid forms; they constitute a rythmically repeated pattern of not very inclined windward sides and steep lee sides (slip-faces). The dune crests may form long, sinoidal lines transverse to the wind. The creation of these sand seas demands enormous quantities of mobile, sorted sand. The big transports arrive from

Fig. 1. A blow-out, a hollow-dune on the west coast of Skallingen, near Esbjerg. In the centre of the photo a person is seen.

almost the same points of the compass. The repeated »wave-forms« are not the result of wind vortexes attached to definite localities (*Cornish, Exner, Matschinski*), but of the self-created shelter and exposition of the superficially transported sand, because the wind behind the slip-faces is morphologically inactive *(Cooper)*. *Longitudinal dunes* are high banks of a partly residual character and with a cross-section whose appearance is changing; this makes the dune-profile more symmetrical than is the case of the barchanoid forms. It is probable that the genesis is strongly affected by a seasonal alternation between two diverging transport directions (*Bagnold, Cooper)*. The *seif dunes* mentioned by *Bagnold* must be classed with this group. *Blow-outs* (German: Windkuhlen) are best known from dunes with vegetation. This term covers the hollows and troughs shaped by the wind in the dunes, see fig. 1. The inside of the hollow is corroded and eroded, while the outer side receives the removed material; the development of an erosion hole is very complicated; however, the formation of vortexes and the macro-turbulence are not necessary as a genetic condition, as maintained (*v. Dieren,* see also *Olson* 1958). *Parabolic dunes (Steenstrup, Solger, v. Dieren, Hack,* *Schou)* — also called *U-shaped dunes (Landsberg)* or *upsiloidal dunes (H. T. U. Smith)* are asserted to be a dune form particular to humid climate zones. It is a question of long, blown-sand banks, resting on a rather plain substratum, and which in a map, thanks to the contour lines, appear as a U-shaped figure. This pattern stands out more clearly in a map than in nature, where it can only with difficulty be distinguished, because the detail forms, the slip-faces and the blow-outs are more conspicuous. The big, Danish parabolic dunes, when regarded in the field, have a big resemblance to seif dunes and secondary barchans; their parabolic axis is said to be dominated by the »wind-resultant«, *Schou, Landsberg, V. Hansen;* see also *Jennings* 1957 and *Finkel* 1959.

A kind of a model

In the following classifications we intend to use a naive model as a condensing agent for notions and explanations. The model fig. 2 represents a bloc of a stylized landscape with the locality A in an environment called O. This primitive figure serves to point out some basic features of the geo-aeolian environment. 1): A dune is an accumulation of blown sand rich in reliefs; the words: »rich in reliefs« show that »dune« is a relative concept; a spot with wind-sedimentation is termed (partly) in accordance with the distribution of heights of the environs; *Schou* 1945, p. 148, remarks that half of the blown-sand covered area of Denmark is avoid of »dune-character«. 2): Suppose that a known dune type, for instance the barchan, is sketched in at A; the block-side of the figure could then represent now 1 m., now 1 km.; still, the constructed situation will correspond to conditions existing in nature, independent of the chosen scale. This goes to show that a certain constancy of forms exists, however, not accompanied by constancy of the terms. 3): If, conversely, the model represents a certain landscape the extent represented by the diagram will contribute to determine »what can be seen« and, consequently, a description and denomination. The normal terms are pronouncedly depending on the »observation height« above the aeolian environment. An example of this peculiarity has already been referred to in the comments on parabolic dunes. 4): A contemplation of fig. 2 may lead to think of the problem known from psychology: What is motive, and what is background, here: $\frac{A}{O}$ or $\frac{O}{A}$? When bearing in mind this association, it is possible to study the landscape in a more untraditional way and to jump at discoveries. During the study of

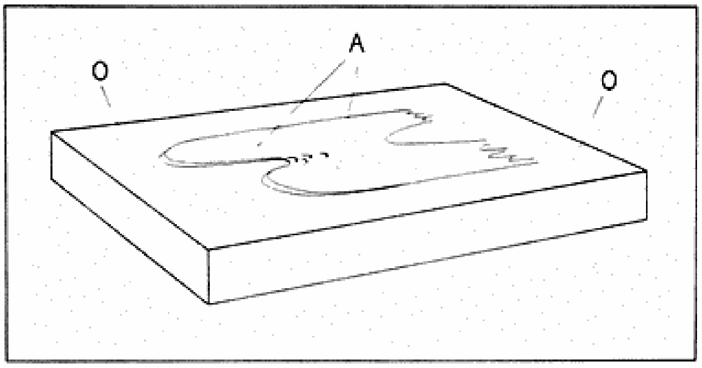

Fig. 2. In general a model of a stylized landscape is shown: an aeolian locality A in the environment O; further information in the text. In particular is demonstrated a schematic outline of a psammogenic shield-dune on a beach.

the development of the blow-outs this manner of treating the problems is useful; for instance, a small deposition of material is discovered in localities where we would immediately have foreseen an erosion. 5): The presentation of this model also is an indication — perhaps not needed — that landscape forms ought to be described in relation to a three-axial co-ordinate system. However, many authors in such descriptions use terms which in reality are surface denominations: White dune and grey dune. For the contemplation of Danish dunes from a solid geometric point of view we refer especially to *A. Schou* 1945 and 1949.

The peculiarities mentioned above make it difficult to compose a »natural« dune terminology.

Dynamical classification

From *Bagnold, Chepil* and others we know that the wind transports material by means of suspension, saltation and reptation. It is possible, in most cases, to identify these transport types each with its delimited grain-size interval: dust (loess), fine-medium sand and coarse-sand/gravel. The dust is suspended in the air-flow, is moved far away and to high altitudes, until the wind dies away. During the movement the sand and the gravel are linked to the surfaces of the terrain; this superficial transport, which is analogous to the hydro-dynamical expression »bed load«, contributes to inducing the morphologists to give »two-dimensional« descriptions. If supposing that the model in fig. 2 represents a locality with active wind it may serve to give an answer to the question: What is the result arrived at in a locality with aeolian activity ? The effect of the wind on the landscape may be temporary or definite; however, at any rate it is useful to classify the result in relation to the transport of material, whether *superficial* or *suspensive*. Both in A and O a net loss of material may take place: *erosion;* or an increase of the sedimentation: *deposition*. If the passage of the sand drifting over the localities does not alter the quantities of material, this is designated by the term: *transit*. Finally, as another possibility should be mentioned that the given localities are not affected by a transport: *neutrality*. It is proposed to reserve the term: »deflation« for a definite kind of aeolian erosion: the removing from non-aeolian sediments and rocks. If the possible combinations of A and O are composed in respect to the four dynamical effects mentioned above we shall be able to make the terminology indicated in table I.

When deposition/erosion occurs in a locality it is because here is found shelter/anti-shelter. Both in common and in scientific usage the term »shelter« indicates a relativity: wind-force reduction in proportion to a »standard force«; therefore, an aeolian terrain-form is created as a natural consequence of a neighbourhood. The shelter/anti-shelter of a locality is ascribable to exterior or interior factors. It may be situated in a wind-shadow from isolated objects sticking out into the air; or it may constitute in itself an obstruction exposed to the wind. The local lee situation may also be conditioned by differences in the structure and contents of neighbouring areas. The

Table I

Aeolian-dynamic terms for a locality (A) in a given environment (O).

	A / O	Dynamical effect in A			
		erosion	deposition	transit	neutrality
Dynamical effect in O	erosion	O>A: erosion-residue A>O: erosion-focus	deposition area	residual transit area	residual neutral area
	deposition	erosion area	O>A: retardative deposition area A>O: deposition focus	transit area	neutral area
	transit	erosion area	deposition area	transit area	refuge area
	neutrality	erosion area	deposition area	(impossible)	(non-aeolian)

different causes of the shelter indicate two types of deposition and erosion: the type conditioned by obstruction and the one conditioned by roughness. The morphologic effect of the obstruction (*obstructogenic)* is due to the influence which a terrain-element of but small extent exercises on the air-current, in which it is a relatively isolated obstruction. Hedges or plant tussocks cast a limited wind-shadow, which may be filled with aeolian material, fig. 3; or, as a result of an isolated elevation of the terrain the stream-lines are situated close to the top of this hill, causing the material of the locality to be exposed to the wind. We would call a deposition caused by a marked wind-shadow *umbratogenic*. The effect of the roughness *(asperitogenic)* is attributable to the frequent difference between the transport capacities of neighbouring areas at a given wind, see *Bagnold* 1954, p. 83, and *Kuhlman* 1958, p. 68. The amount of the transported material in a given surface is determined by the nature, size and distribution of the roughness-elements. Immobile, smooth surfaces have an extremely big, optimal transport capacity, even if the surface is moist. In Denmark the pseudo-hygrophoby of the saltating sand is of fundamental importance. We have learned with astonishment that wet dune surfaces are erosion areas, and that moist material does not inevitably bring the drifting to a standstill. The optimal, equivalent transport is smaller on a dry, loose sand surface than on a smooth, firm surface; this is why the psammogenic dune formation takes place *(H. T. U. Smith; Schou* 1945: Physical dune formation). We have only with difficulty understood the observation according to which sand could be accumulated without a pronounced shelter. The transport conditions of a rough, semi-mobile surface are of a peculiar nature; at gentle winds the equivalent transport is smaller here than on a loose sand surface, whereas it is bigger at strong winds. A mobile sand-spot in a pebbled locality will act as an erosion area at moderate wind forces and as a deposition area at strong winds. The surfaces grown with plants have only a small sand movement or none at all; almost invariably they are deposition areas. The capability of certain plants for regenerating the surface type after the deposition of the sand is well known. The optimal growth of Ammophila arenaria demands sanding-up. Although plants often create stable sediment-sections, and in spite of the fact that dunes characterized by vegetation have a complicated evolution the author does not see the practical in pointing out the shelter of the plants as a specific, odd phenomenon: the organogenic (phytogenic) dune formation; the vegetation functions as shelter in the same manner as do the

Fig. 3. An umbratogenic deposition — a prismatic dune — of soil material in a road side, Thy. The soil-drift had taken place from right.

inorganic terrain elements, and the aeolian landscape forms which the vegetation develops have a striking resemblance to »physical« types.

Grouping of wind-sediments

In Denmark several kinds of wind-sediments occur; it is not intended here, when commenting upon these sediments, to use the traditional groupings according to texture, composition and the like, whereas we recommend a classification based on the nature and the effect of the transport. This classification has previously been dealt with in the present periodical (1957, 1959). We propose the following denominations: suspension-, saltation-, reptation-, slip- and residual sediment and corroded material. Observations in nature have shown that these terms are closely associated with the textural terms. *Aeolian suspension material* is rarely found deposited in appreciable quantities in this country, see *S. A. Andersen* 1935 and *S. Hansen* 1948, whereas every year in numerous plough fields in Jutland a rise takes place of suspensive, aeolian material, whose future fate is only uncompletely known. The *saltation material,* whose predominant grain size is 0.15 - 0.40 mm., forms the bulk in the numerous dunes and blown-sand covers the position of which is given in »Atlas of Denmark« (*Schou* 1949); their total area is said to be about 1.400 sq. km. (*Schou* 1945). The *reptation material* forms an integrating part of the »blown sand« in dunes and covers; however, it may have grain sizes six times as big as those of the local, saltating sand; this leads to the formation of sporadic dune material which is so coarse-grained (10 mm.; commonly: 1-5 mm.) that hurricanes have been considered as necessary for their accumulation; however, this is not the case (see *Kuhlman* 1960, fig. 3). Separated, coarse reptation material is especially found in the dunes in Western Thy, at Grindsted and on Anholt. In our climate wet, steep erosion slopes of aeolian material are not unusual; when slidings happen in these slopes and at slip-faces an *aeolian slip-sediment* is formed, characterized by being situated low in the terrain and by being relatively poorly sorted. The land-slides and slips steered by gravitation make it difficult to identify the aeolian environment sedimentologically. *Residual sediments* consist of pebbles and cobbles, left by the wind in a process of deflation; we meet »pavements« just as in arid deserts — a phenomenon which may be observed at many places along our recent beaches, for instance at Skallingen and Blåvands Huk. At Kandestederne, near the Scaw, are also found planes with pebbles, resulting from a wind-erosion in elevated, marine sediments. Many agrarian fields in Jutland may in spring have the same wind-ravaged aspect. Among the *materials influenced by corrosion* we know from Jutland numerous occurrences of faceted pebbles/cobbles, which lie in the field-soil on glacial material from the Riss glaciation; the period of their shaping is probably Würm (Tubantian, Weichsel). The best opportunity of studying these polished field pebbles is found in the district between Holstebro and Ringkøbing, and Grindsted-Hejnsvig. In Bornholm have been observed wind-sculptured rock surfaces (*Mattsson* 1957).

It is worth noticing that only the two last-mentioned sediment types may be interpreted stratigraphically as having been caused by wind-erosion. If the other types are embedded in a stratification a later researcher will undoubtedly conclude that a deposition has taken place in an aeolian environment. Much of what we characterize to-day as erosion localities cannot, at a later embedding, be given this name. The plains surrounding the parabolic dunes are termed by some authors as: deflation plains; however, this expression is not too well chosen, because from a stratigraphic-dynamic point of view they are most often underdeveloped deposition areas. This is

Fig. 4. Lense-dunes — cushion dunes — on the western beach of Rømø; the houses of Lakolk are seen in the background. The genesis of dunes, half a metre high, is named asperitogenic.

one of the reasons why the author recommends only to use the term: deflation when the wind removes »foreign« material.

Geometrical grouping

The geometric figuration of a locality in the landscape influenced by the wind may be divided into a few elementary forms. Such a division in constituents is known from other dune topographies; however, our system is perhaps of a greater simplicity and consistency.

The first sort to which we are drawing the attention may seem to be a truism: a locality *non-specific* in relation to the environs; however, it is overlooked that the wind-ravaged spot often forms a vaguely marked element of the landscape. In Denmark it is common that ancient or recent wind-activity cannot be immediately deduced from the shape of the terrain; it is necessary to observe the very transport or to study the soil more closely. In Vendsyssel-Thy and in Himmerland the soil-drifting hits big field-areas every year without leaving any distinct morphological effects; further, cultivation and road-work eliminate most of the small traces. The geological

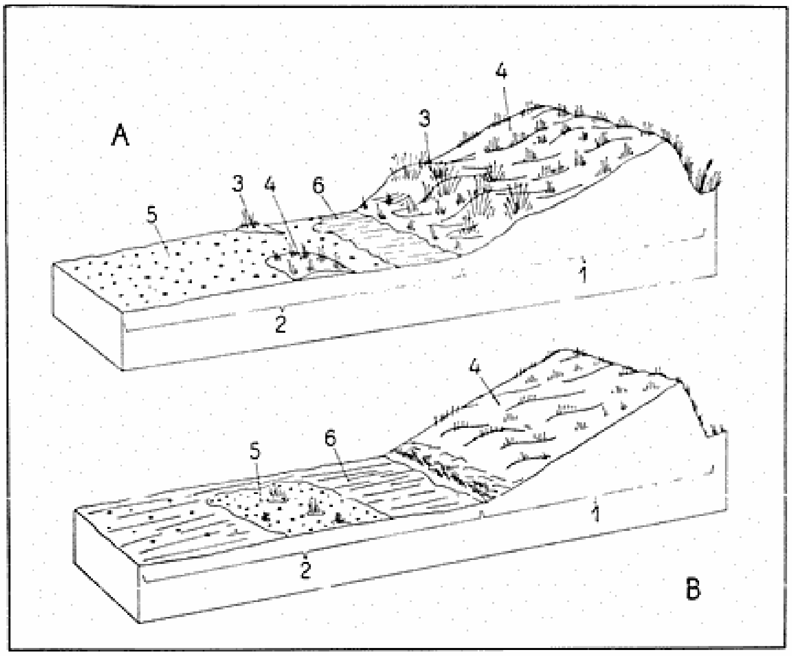

Fig. 5. The transition from beach to coast dunes west of Skomagersletten, Skallingen. Summer: A and winter: B in 1954—1956. 1 = the coast dune, an 8 m. high profile dune. 2 = the beach. 3 = umbratogenic tongue dunes. 4 = lense dunes (cushion dunes). 5 = an aeolian, asperitogenic transit plane. 6 = beach washed by the sea. The block side represents 150 m., and the exaggeration is about 10.

mappings *(Milthers, Jessen)* have shown that moraine hills in Western Jutland and in Central Jutland at places are conformably covered by Late-glacial aeolian sand; this corresponds to the cover-sand from Holland and Germany, of which descriptions have been given (cf. *Kuhlman* 1959). From the aeolian-non-specific localities there are continuous transitions to *planes* with aeolian material. The deflation planes with »pavements« known from arid regions exist, as mentioned, in our country too; however, plains with blown sand are much more common. Initial deposition areas are more easily found than embryonal erosion spots; the umbratogenic deposition has an outstanding initial form: the *tongue dune;* as the name indicates, the material adopts a shape resembling a cleaved cone resting on the cleave plane in the shelter of a wind-obstructing object (compare *Cooper's* »lee projection«). Behind a onesidedly extended shelter tongue dunes may grow together so as to form prismatic drifts: *prismatic dunes.* The commencing asperitogenic deposition forms lenses more or less asymmetric, fig. 4; we suggest the term: *lense dunes.* Usually, they are called embryonal dunes, primary dunes, tussock dunes and other names. When it is a question of isolated

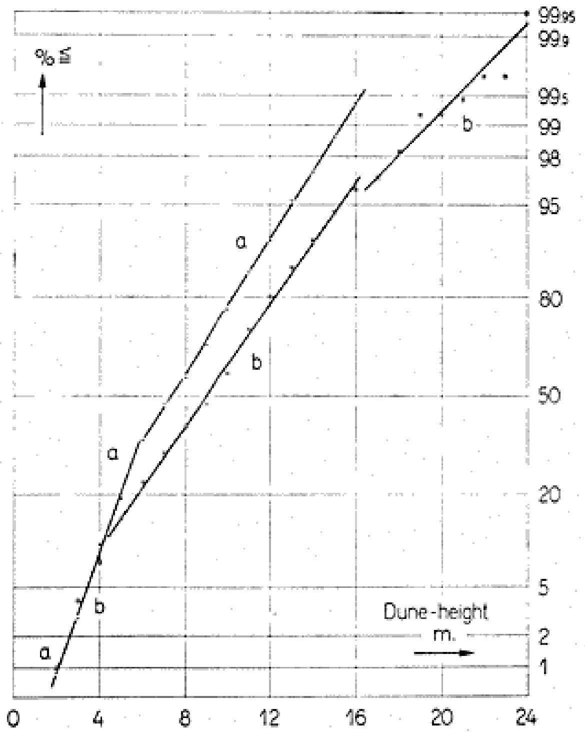

Fig. 6. The frequency distribution of the estimated dune heights in Blåvand — Rømø (a) and Frederikshavn — The Scaw (b) plotted on probability paper.

occurrences this initial form rarely has a thickness of more than a few decimetres, whereas its ground area may be big. At Danish coasts two sub-types are frequent; one of them is seen in planes with no vegetation: *shield dune;* it has a slightly curved shape which, if the material is moist, is provided with a steep micro-slope against the wind (fig. 2). The other sub-type appears in places where there is some vegetation; its shape is expressed in the name: *cushion dune* (fig. 4). Both are embryos of a later stable dune formation; they consist of semi-hygrophobic sand, which becomes the source material of the future drift. It is most probably a question of shield dunes, mentioned by *Schou* 1945, p. 151, and by *Cooper* 1958, p. 46.

Big, asperitogenic accumulations of saltation material acquire by and by the figuration which is usually associated with the term »dune«. The characteristic of these accumulations is the presence of slip-faces, slopes of 25°-30° with loosely packed material, and the opposite orientated slopes of 5°-12°. As a result of this the vertical profile becomes »barchanoid«, i. e. triangular with constant angles. Leaving out of consideration the figuration of such dunes in the horizontal section, we name them all: *profile dunes* (fig. 5): a basic form comprising a series of common names, for instance the beach barchan, the secondary barchan, elements of sand seas, Dunus anticus, and parabolic dunes. The barchan is a well defined sub-type and, perhaps, the real primary form; however, we need more observations for being able to pronounce a judgment. The height of profile dunes is generally said to be 10-30 m., rarely 100 m. In this country no dune is rising more than 25 m. above its bed; however, it may sometimes be difficult to establish the level of the dune basis. In fig. 6 is shown the distribution of the heights of the dune tops (found during studies of map 1:20.000) in two Danish dune areas: The Scaw — Frederikshavn and Blåvand — Rømø. The approximate top constancy, which is dimly seen in the figure, has dynamical causes. The wind force increases with the height above the terrain; at a certain level the force will be equal to the suspension threshold of the local sand (see *Kuhlman* 1960), and if an isolated accumulation of sand grows to such a height that the normal winds of the region have a suspensive effect at this level the »dune-hat« is blown off; a suspensive transport does not create any topography rich in reliefs, only covers. The theoretically maximum dune height is positively correlated with the grain size of the material, but negatively correlated with the degree of isolation of the dune and the usual local wind forces.

Large dunes with vegetation may have a more symmetrical cross-section than is normally the case of profile dunes; when regarded from a certain distance, they have the aspect of banks with a curved, elliptic cross-section. These *bank dunes,* unsatisfactorily defined, are especially seen at progressive coasts with nutritious sand, for instance Rømø and the Scaw. In mobile material the wind may form big erosion areas with bizarre micro-forms; big, steep slopes are shaped, sculptured by corrosion. In North-Western Europe the erosive effect is pronounced because of the frequent weather changes and the resulting big fluctuations of the degree of moisture of the material; moist sand may stand in vertical inclinations, which slide when dried in fine weather. Moist surfaces between dry areas are strongly corroded on account of their great transport capacity, which, in addition, accentuates an adjacent accumulation. In our dunes the erosion areas and the deposition areas stick together, just as the front and the back of the paper, see *v. Dieren* 1934, p. 198. The characteristical initial form in a deflation area is the somewhat oblique *wind-hollow* or *wind-trough;* when old dune-material is eroded, *hollow-dunes* and *trough-dunes* are born (fig. 1).

Table II.

Form-type	Material	Dynamical class	Normal synonymous	Locality example
Formarten	*Materialet*	*Dynamisk klasse*	*Normal synonym*	*Lokalitet eksempel*
aeolian non-specific	residual gravel + pebbles	asperitogenic/obstructogenic deflation	fields with wind erosion	North Jutland
æolisk uspecifik	*residual grus + sten*	*asperitogen/obstruktogen deflation*	*jordføgne agre*	*Nordjylland*
	saltation-/reptation-sand+gravel	asperitogenic/obstructogenic deposition	drifts covers	Near Fjerritslev
	saltations-/reptationssand og grus	*asperitogen/obstruktogen deposition*	*dækker driver*	*Omkring Fjerritslev*
aeolian plane	layer of residual gravel and pebbles	asperitogenic deflation/transit	pavement sheets with pebbles	Kandestederne at the Scaw
æolisk plan	*lag af residual grus og sten*	*asperitogen deflation-transit*	*brolægning stensletter*	*Kandestederne ved Skagen*
	mixed, partly mobile	asperitogenic erosion	deflation plane	Foreshore of the West coast
	blandet, delvis mobilt	*asperitogen erosion*	*deflationsslette*	*Forstranden, Vestkysten*
	saltation-/reptation + vegetation	asperitogenic deposition	blown-sand sheet	At Blåvand Kalsmærsk Heath
	saltations-/reptations + vegetation	*asperitogen deposition*	*flyvesandsslette*	*Ved Blåvand, Kalsmærsk Hede*
tongue-dune	saltation-/reptation	umbratogenic deposition	lee-tongue embryonal dune	Foreshore Skallingen, Fanø
tungeklit	*saltations-/reptations*	*umbratogen deposition*	*lætunge embryonalklit*	*Forstranden Skallingen, Fanø*
prismatic dune	saltation-/reptation	umbratogenic deposition	lee-drifts	Foreshore Skallingen, Fanø
prismeklit	*saltations-/reptations*	*umbratogen deposition*	*lædriver*	*Forstranden Skallingen, Fanø*
small lensedunes *små linseklitter*	saltation-/reptation- *saltations-/reptations*	asperitogenic deposition *asperitogen deposition*		Foreshore Skallingen, Fanø
shield-dune *skjoldklit*	÷ vegetation *÷ vegetation*		primary dunes *urklitter*	*Forstranden Skallingen, Fanø*
cushion-dune	+ vegetation		tussock dune embryonal dune	Foreshore of Rømø
pudeklit	*+ vegetation*		*tueklit embryonalklit*	*Rømøs forstrand*
big lensedunes	+ vegetation	asperitogenic + umbratogenic deposition	foredune sea-dune Dunus anticus	Skallingen, Fanø Rømø
store linseklitter	*+ vegetation*	*asperitogen + umbratogen deposition*	*forklit, havklit Dunus anticus*	*Skallingen, Fanø Rømø*
profile dunes *profilklitter*	saltation-/reptation	asperitogenic/obstructogenic deposition		
	saltations-/reptations	*asperitogen/obstruktogen deposition*	beach barchan sec. barchan	(Fanø) Råbjerg Mile
	÷ vegetation *÷ vegetation*		*strandbarkhan sek. barkhan*	*(Fanø) Råbjerg Mile*
	+ vegetation		Dunus anticus	Skallingen
	+ vegetation		*Dunus anticus*	*Skallingen*
			parabolic dune sec. barchan	Jessens Sande Ho
			parabelklit sek. barkhan	*Jessens Sande Ho*
hollow-dune	mobile sand + vegetation	asperitogenic/obstructogenic erosion + deposition	blow-out	SW-Fanø
	mobilt sand + vegetation	*asperitogen/obstruktogen erosion + dep.*	*vindkuler*	*SW-Fanø*
trough-dune	mobile sand + vegetation	asperitogenic/obstructogenic erosion + deposition	deflation furrows	NW-Thy
trugklit	*mobilt sand + vegetation*	*asperitogen/obstruktogen erosion + dep.*	*deflationsfurer*	*NW-Thy*
wind-hollow *vindgryde*	mixed, mostly mobile	asperitogenic/obstructogenic erosion		
wind-trough *vindtrug*	*blandet, mest mobilt*	*asperitogen/obstruktogen erosion*		

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An outlined system and a summary

An exhaustive systematics in Danish aeolian landscapes cannot be established until more quantitative observations are available; however, it is possible to give a summary of the terms mentioned in the preceding paragraphs, ranged according to an outlined system; this has been done in table II.

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