# 6. DISPERSABILITY TRAITS

**General introduction**

Seed dispersal, or the transport of seeds away from a parent plant, is an important process in the regeneration of most of the higher plants. Its evolutionary importance is illustrated by the mechanisms and structures of plants that promote seed dispersal. Seed dispersal is advantageous to plants when it enhances seed survival and increases reproductive success, and it may do so in various ways. First, dispersal reduces the risk of distance- or density-dependent mortality. Second, seed dispersal theoretically enhances a plant's chance to place seeds in suitable establishment sites. Third, dispersal may improve germination when it involves passage through the gut of animals. Other possible advantages of seed dispersal are colonization, area extension, and gene flow.

Plant species often have more than one dispersal mode and seeds of all species might be dispersed by all kinds of dispersal vectors. Conventional classification systems use only binary assignment schemes classifying each species as either being dispersed by means of a certain dispersal vector or not. However, for ecological questions it is important to know (i) if the dispersal vector is capable of long-distance dispersal (LDD), and (ii) how efficiently the species is dispersed by this vector. In LEDA, gradual differences in the dispersability of plant species will be expressed by dispersal potentials. Dispersal potentials will be estimated from the literature for anemochory (dispersal by wind), hydrochory (dispersal by water), epizoochory (adhesive dispersal), endozoochory (internal animal dispersal), hemerochory (dispersal by man) and scatter hoarding. The attachment capacity, survival rate after digestion, buoyancy and terminal velocity will be measured as indicator parameters for the dispersal types epizoochory, endozoochory hydrochory and anemochory, respectively. For the final trait analysis, new measurements will be combined with those from the literature.

# 6.1. SEED RELEASING HEIGHT

*K. Thompson and D. Kunzmann*

**Introduction**

The significance of seed releasing height is particularly obvious for wind dispersal, the effectiveness of which is largely determined by two plants traits; seed releasing height and terminal velocity of the diaspore (Tackenberg 2003). The potential for effective wind dispersal is greatest in species with a large releasing height and a low terminal velocity. However, these two traits do not act independently; the lower the heights of release, the more seeds are dependent on a low terminal velocity to achieve effective dispersal. Conversely, tall plants (e.g. trees) may achieve significant wind dispersal with only a moderately low terminal velocity (Nathan *et al*. 2002). Releasing height is also important for ectozoochory; the height at which ripe diaspores are presented will strongly influence the type of animals that might disperse them (Fischer *et al*. 1996). Indeed, the low probability of tree seeds encountering most mammals has been suggested as the reason for the scarcity of seeds with specific adaptations for ectozoochory among plants > 2 m tall

(Hughes *et al*. 1994). Arboreal mammals may make poor dispersal vectors on account of their ability rapidly to remove adhesive seeds.

*Trait definition*
For the great majority of plants the <u>seed releasing height = plant height</u>, i.e. the highest point of the plant is a flower, and subsequently seeds or fruit. Therefore for many plants, although certainly not all, seed releasing height may be greater than canopy height. It cannot automatically be assumed that seed releasing height = flower height (see Special cases below).

**How to measure**
Releasing height should be measured near the end of the growing season, and should be measured as the difference between the elevation of the highest fruit or seed and the base of the plant. The same type of individuals as for canopy height should be sampled (see Chapter 1.2), i.e. healthy, adult plants that have their foliage exposed to full sunlight (or otherwise plants with the strongest light exposure for that species). However, because releasing height is much more variable than some of the leaf traits, measurements are taken preferably on at least 25 individuals per species.
The height to be measured is the height of the inflorescence (or seeds, fruits), which fre-quently projects above the foliage. Measure releasing height preferably towards the end of the growing season (but during any period in the non-seasonal Tropics), as the shortest distance between the highest seed or fruit and ground level.

For estimating the height of tall trees there are several options (see also Figure 3.3):
1. A telescopic stick with metre marks.
2. Measuring the horizontal distance from the tree to the observation point ($d$) and the angles between the horizontal plane and the tree top ($\alpha$) and between the horizontal plane and the tree base ($\beta$). The tree height ($H$) is then calculated as: $H= d$ x [tan($\alpha$) + tan($\beta$)]. This method is appropriate in flat areas.
3. Measuring the following 3 angles: (1) between the horizontal plane and the tree top ($\alpha$); between the horizontal plane and the top of an object of known height ($h$; e.g. a pole or person) that is positioned vertically next to the trunk of the tree ($\beta$); and (3) between the horizontal plane and the tree base (which is the same as the base of the object or person) ($\gamma$). The tree height ($H$) is then calculated as: $H= h$ x [tan ($\alpha$) - tan ($\gamma$)] / [tan ($\beta$) - tan ($\gamma$)]. This method is appropriate on slopes.

*Special cases*
- In herbaceous species, 'stretched length' (see Chapter 1.2) does not apply: <u>releasing height is always height of the ripe seeds from the ground</u>.
- In some cases, releasing height is less than plant or canopy height, e.g. some shrubs with major extension growth of stems after flowering, some *Carex* tus-socks. Also in some herbs (e.g. *Cyclamen* spp.), the flowering stem normally bends or collapses after flowering; here the seed releasing height may be much less than the flowering height.

- In the case of epiphytes or certain hemi-parasites (which penetrate tree or shrub branches with their haustoria), releasing height is defined as the shortest distance between the highest fruit and centre of their basal point of attachment. Record releasing height for species that use external support, i.e. twines, vines and lianas, as distance from the ground.
- The seed releasing height for <u>water plants</u> is measured as the distance between the highest point of inflorescence and the water surface.
- For small populations or rare species a minimum of 3 replicates (instead of 25 replicates) is accepted.

**Minimal requirements**

To estimate releasing height BIOPOP1 used drawings from the German flora (see also Chapter 1.2). These data will be incorporated into the LEDA Traitbase, however note that the statistical quality of this method is low, because the ranges of minimum and maximum height are only field observations with an unknown number of replicates.

To obtain the releasing height of the species missing from the BIOPOP list, the standardised measuring protocol of releasing height (as described above) should be used.

When in any published source the 'seed releasing height' is a real measurement (i.e. not derived from drawings), information on the number of replicates, mean or median with the standard deviation or standard error is obligatory. Missing information on one of the above mentioned criteria will result in rejection of the data.

For releasing height field data are preferred, but data from garden experiments are accepted with additional information about the sample site (see general standards). In the LEDA Traitbase the seed releasing height will be expressed in metres, but data expressed in other units will be accepted and converted to metres.

Unless otherwise stated, 'plant height' in floras can be assumed to be (maximum) releasing height. For example, in the standard British flora (Stace 1997), the height of *Digitalis purpurea* is given as 'up to 2 m', and *Hypochaeris radicata* as 'up to 60 cm'.

**Data structure**

To collect: 1 height measurement of 25 different individuals per species (per site) = 25 heights in total per species

Obligate:
- Type of variable: numerical
- Sample size (n): 25
- Number of replicates (N): 1
- Unit: m
- Values: N, mean, median, standard deviation, standard error
- Method used:
  1. Obtained by measurements (standardised protocol)
  2. Obtained from measurements of published data
  3. Estimated from drawings
- Validity range: 0-70 (for European plants)
- External support structure:
  1. Yes
  2. No

3. Unknown
*Note:* For external support structure 'yes' is <u>only</u> used for lianas, climbers (both measured with support structure) and epiphytes (measured without their support structure).
- Collecting date: day/month/year (dd.mm.yy)

Optional:      o  Comment field: Any information of importance to the trait

# 6.2. TERMINAL VELOCITY
*K. Thompson*

**Introduction**
If a seed is dropped from some height it acquires a 'terminal' velocity, this is an important characteristics in wind dispersal of diaspores (Augspurger 1986).
The pull of gravity on any object is a constant value, but the effect of air resistance depends on the object's size, density and shape. These three factors determine the rate of fall through still air. Theoretically the object or particle will start falling at a slow rate but will accelerate until it reaches its maximum rate of fall, which we call its 'terminal velocity'. Air movement also affects the rate of fall, and if the airflow is upward, it can oppose gravity, thus reducing the rate of fall. If the air velocity equals the 'terminal velocity' of the seed, the seed will float, but if the air velocity exceeds the 'terminal velocity', it will lift the seed. Seeds have different 'terminal velocities' due to different size, density or shape, therefore some will fall while smaller, lighter and/or 'wingier' seeds will be lifted by the air stream (Kice 2002). This 'uplifting' is of great significance for dispersal of seeds by wind; long-distance dispersal by wind is only likely to be achieved by seeds that are uplifted (Nathan *et al*. 2002, Tackenberg 2003).
This theory shows the importance of the wings and plumes of diaspores is to delay the fall, for as long as it is in the air the wind can act upon it. This is the reason that the wings are often found to be oblique, causing the fruit to rotate under the wind, which carries it a further distance before it reaches the ground. The longer it takes to reach the ground and remains under the influence of the wind, the further a seed or fruit can be dispersed (Ridley 1930). Note that structures that slow the rate of fall of seeds (e.g. wings or pappus) do not usually impart any horizontal velocity themselves.

*Trait definition*
<u>Terminal velocity:</u> The maximum rate of fall in still air, i.e. the rate of fall when the effects of gravity are balanced by air resistance.

**How and what to collect**
Measurements should be conducted on the dispersule, i.e. on the seed or fruit with all its normal attached structures, e.g. pappus, wing(s), awn(s). If there is any doubt about which structures should be included, measure terminal velocity both with and without. Species with fleshy fruits; measure the isolated seed only, without the fleshy part. Note

that it may sometimes be unavoidable to measure the trait on the germinule e.g. on account of difficulty of obtaining undamaged dispersules.

**What to measure**

Ideally, freshly-collected air-dry seeds should be measured, but older stored seeds may have to be measured in some cases. It is important that dispersal structures (esp. pappus) are undamaged. It is impossible to specify exact methods for measurement of terminal velocity, since there are at least two fundamentally different approaches. First, measurements of actual rate of fall in still air (e.g. Askew *et al*. 1996; see Fig. 3.21). Secondly, measurements of air speed when the seed is suspended in a vertical air flow (e.g. Jongejans & Schippers 1999). Generally the two methods give similar results (Jongejans & Schippers 1999). The latter method automatically measures terminal velocity, but the former will only measure terminal velocity if the seed is allowed to complete its acceleration before velocity is measured. Heavy seeds may need to fall several metres before they achieve terminal velocity, but the errors potentially involved are of little ecological significance – seeds that fall at $> 2$ m sec$^{-1}$ are very unlikely to be effectively dispersed by wind (Tackenberg *et al*. 2003). The overriding concern will be that the LEDA Editorial Board is satisfied that the method is accurate enough to provide measurements to at least one decimal place.



***Figure 3.21.*** *Experimental set up for the measurement of the terminal velocity of dispersal units.*

**Minimal requirements**

Data obtained from diaspores originating from greenhouse or garden experiments are only accepted when all obligate fields can be completed.

**Data structure**

To collect:    10 intact dispersules per species for terminal velocity

*Note*: One measurement on one seed is a single observation, and there fore N is the number of seeds measured (the individual measurements are not reported.

Obligate:
- Type of variable: numerical
- Sample size (n): 10
- Number of replicates (N): 1
- Unit: m s$^{-1}$
- Values: N, mean, median, minimum, maximum, standard deviation, standard error
- Method used:
    1. Obtained by measurements (standardised protocol)
    2. Obtained from measurements of published data
- Unit measured - diaspore categories:
    1. Vegetative dispersule
    2. Generative dispersule
    2a. One-seeded                    2b. Multi-seeded
    3. Germinule
    4. Unknown
- Trait specific method:
    1. Measured in air speed with seed suspended in vertical flow
    2. Measured actual fall rate in still air
    3. Unknown
- Validity range: 0.01 – 10
- Collecting date: day/month/year (dd.mm.yy)

Optional:    o  Comment field: Any information of importance to the trait

# 6.3. BUOYANCY

*C. Römermann, O. Tackenberg and P. Poschlod*

**Introduction**

The trait buoyancy (floating capacity) is an indicator parameter for the potential of a species to be dispersed by water. The longer the seeds of a species can float on water, the further they can be dispersed, though it is also dependent on the flow velocity (lakes, ditches, rivers). However, not only the maximum floating time but also the proportion of seeds floating for certain time period is an important parameter related to dispersal potential by water.

*Trait definition*

<u>Buoyancy:</u> A measure of the floating capacity of diaspores on water, indicating a certain dispersal potential.

<u>Floating capacity potential:</u> Indication given to species to indicate their potential to be dispersed via water.

## How and what to collect and measure

Measurements should be conducted on the dispersule, i.e. on the seed or fruit with all its normal attached structures, e.g. pappus, wing(s), awn(s). Note that it may sometimes be unavoidable to measure the trait on the germinule e.g. on account of difficulty of obtaining undamaged dispersules. If there is any doubt about which structures should be included or if a species has heteromorphic diaspores, buoyancy is measured on all diaspore types. For species with fleshy fruits both the whole fruit and the isolated seeds only (without the fleshy part) should be measured. To measure floating capacity, two seed sets of each 100 seeds per species (= 200 seeds in total per species) need to be collected, if possible from plants growing in their typical habitats and from different individuals.

Floating capacity is given as the proportion of seeds still floating after a defined time period. The floating capacity will be measured with 100 seeds per species and two replicates as Bill (2000) has shown a low variability in the results in similar experiments. The seeds are gently put in glass beakers (10 cm width, 12 cm height; volume: 600 ml) filled with about 300 ml distilled water. The beakers are placed on a flaskshaker (Fig. 3.22) which gently moves with a frequency of 100/minute and has an amplitude of about 1 cm. According to Van Diggelen & Boedeltje (pers. comm.), differences observed between the species are already steady after 1 week, largest changes occur within the first day. Therefore, the observations of the proportion of seeds still floating will be carried out at the following intervals:

Floating time intervals

| Interval: | Time step: | In minutes: |
|-----------|------------|-------------|
| T0 | immediately | 0 |
| T1 | 5 min | 5 |
| T2 | 1 hour | 60 |
| T3 | 2 hours | 120 |
| T4 | 6 hours | 360 |
| T5 | 1 day | 1440 |
| T6 | 1 week | 10080 |
| T7 | 2 weeks | 20160 |
| T8 | 3 weeks | 30240 |
| T9 | 1 month | 43344 |
| T10 | 6 months | 262080 |
| T11 | 1 year | 524160 |
| T12 | >1 year | > |

The data sheet for the input of measured data (see data structure) will comprise the mean and median floating capacity, N (number of replicates), the standard deviation, the stan-

dard error, the minimum and the maximum, the time step as well as information about the examined dispersal unit (according to the trait 'Morphology of dispersal unit'; see Chapter 5.4).

Generally, the entries for the field 'time step' do not need to be in accordance with these data standards. For data comprising only $T_{50}$ or $T_{90}$ (time 'T' when 50% or 90% of the seeds have sunk), the mean floating capacity is 50 % (or 10%), the time interval is the given value in days. For example *Carex hirta*:

Data set 1:     mean floating capacity = 50 %   Time step = 20.25 days.
Data set 2:     mean floating capacity = 10 %   Time step = 112 days.
resulting in $T_{50}$ = 486 hours (or 20.25 days) and $T_{90}$ = 112 days

**Minimal requirements**
The mean, N (number of replicates), the minimum and maximum are required. Furthermore, information about the measured dispersal unit (seed or diaspore) is obligate information.
If less seeds than 200 are available, the experiment can exceptionally be conducted with less seeds per replicate.



*Figure 3.22.* *Measurement of the floating capacity of seeds using a flaskshaker.*

**Data structure**

To collect:    In total 200 seeds per species (100 seeds per replicate)

Obligate:
- Type of variable: numerical
- Sample size (n): 100
- Number of replicates (N): ≥ 2
- Unit: %
- Values: N, mean, median, minimum, maximum, standard deviation, standard error
- Buoyancy time steps:
    - T0.  Immediately
    - T1.  5 min
    - T2.  1 hour
    - T3.  2 hours
    - T4.  6 hours
    - T5.  1 day
    - T6.  1 week
    - T7.  2 weeks
    - T8.  3 weeks
    - T9.  1 month
    - T10. 6 months
    - T11. 1 year
    - T12. >1 year
- Seed structure: see Morphology of dispersal unit (Chapter 5.4)
- Diaspore type: see Morphology of dispersal unit (Chapter 5.4)
- Dispersal type: see Table 3.6 (Chapter 5.8)
- Dispersal vector: see Table 3.7 (Chapter 5.8)

Optional:
- o  Comment field: Any information of importance to the trait

# 6.4. EXTERNAL ANIMAL DISPERSAL (EPIZOOCHORY)

*C. Römermann, O. Tackenberg and P. Poschlod*

**Introduction**

Dispersal systems such as passive animal dispersal may play important roles in seed dispersal. The dispersal in which seeds are carried away from parent plants by attachment to the surface of animals is called ectozoochory, epizoochory or external animal dispersal.
The trait attachment capacity is an indicator for epizoochory; it shows how long a seed remains attached to the fur, i.e. how far it is dispersed by animals.

*Trait definition*

External animal dispersal:  Dispersal of diaspores by means of attachment to the fur, hooves etc. of animals (also known as ecto- or epizoochory).

Attachment capacity:  A measure to indicate how well diaspores can be dispersed via ectozoochory.

**How and what to collect/measure**

Measurements should be conducted on the dispersule, i.e. on the seed or fruit with all its normal attached structures, e.g. pappus, wing(s), awn(s). If there is any doubt about which structures should be included or if a species has heteromorphic diaspores, attachment capacity is measured on all diaspore types. For species with fleshy fruits both the whole fruit and the isolated seeds only (without the fleshy part) should be measured. For the trait attachment capacity, six seed sets each of 100 seeds per species (= 600 seeds in total per species) need to be collected, if possible from plants growing under natural conditions and from different individuals.

Attachment capacity is measured as the proportion of seeds still attached to a shaken animal fur. It is measured by using the shaking machine ('Rüttelmaschine', Fig. 3.23) according to the methods described in Talmon (2002). The experiments are carried out on sheep wool and on cattle fur. The piece of animal coat nailed on a wooden board of 30 x 50 cm, is homogenised using a special 'comb' (board with wooden pins). Hundred seeds per species (with all appendages) are combed into the hair, after which the coat pieces are installed at the sides of the machine. The value 'attachment capacity' refers to the percentage of seeds still attached to the fur after 2400 shakes (equivalent to 1 hour when shaking with 40 hubs/ minute).



**Figure 3.23.** *The shaking machine used to measure attachment capacity. A comb is used to homogenise the coat and to comb the seeds into the wool or hair.*

The experiments are carried out on 3 replicates each for sheep and cattle coats. The data sheet for the input of measured data (see Data structure) will comprise the mean and median percentage attachment capacity, the dispersal vector, N (number of replicates), the standard deviation, the standard error, the minimum and the maximum as well as information about the examined dispersal unit (according to the categories of the trait 'Morphology of dispersal unit').

**Minimal requirements**

The mean of the replicate measurements, N (number of replicates), the standard deviation, the minimum and the maximum are given. Other obligate information concerns the method used and the dispersal unit stage.

If less than 600 seeds are available, the experiment can exceptionally be conducted with less seeds per replicate.

**Data structure**

To collect:    In total 600 seeds per species (100 seeds per replicate)

Obligate:    ● Type of variable: numerical
   ● Sample size (n): 100
   ● Number of replicates (N): 6
   ● Unit: %
   ● Values: N, mean, median, minimum, maximum, standard deviation, standard error
   ● Seed structure: see Morphology of dispersal unit (Chapter 5.4)
   ● Diaspore type: see Morphology of dispersal unit (Chapter 5.4)
   ● Dispersal type: see Table 3.6 (Chapter 5.8)
   ● Dispersal vector: see Table 3.7 (Chapter 5.8)

Optional:    o Comment field: Any information of importance to the trait

# 6.5. INTERNAL ANIMAL DISPERSAL (ENDOZOOCHORY)

*C. Römermann, O. Tackenberg and P. Poschlod*

**Introduction**

Endozoochory, the interaction between diaspores and the animals that ingest and disperse their seeds, has been the subject of many ecological studies (e.g. Janzen 1984, Clausen *et al*. 2002). In many vegetation types, mammals and birds are attracted to and disperse seeds because of the reward provided by edible parts of the fruits or seeds. Large herbivores are often used for the management of heathlands and species rich grasslands. The use of these large grazers to a very large degree determines the dispersal of plant diaspores as many seeds are eaten by herbivores and survive digestion.

The 'survival rate after digestion' indicates how efficiently a species is dispersed via the animal's gut. In the LEDA Traitbase, the survival rate is given as the mean percentage seeds having survived simulated digestion in comparison to the control.

*Trait definition*

Internal animal dispersal:  Dispersal of diaspores by means of the digestive system of ani-
mals (also known as endozoochory).

Survival capacity:  A measure of how well a diaspore can survive the digestive tract to be
able to be dispersed via endozoochory.

## How and what to measure

The (relative) survival rate after digestion is measured as the proportion of viable seeds
after an experimentally simulated digestion in relation to the viability of an untreated con-
trol. Measurements should be conducted on the apparently viable dispersule, i.e. on the
seed or fruit with all its normal attached structures, e.g. pappus, wing(s), awn(s). If there
is any doubt about which structures should be included, measure survival of digestion
both with and without. Species with fleshy fruits; measure the isolated seed only, without
the fleshy part.

For the trait survival rate after digestion, 10 seed sets each of 150 seeds per species (=
1500 seeds in total per species) need to be collected if possible from plants growing
under natural conditions and from different individuals. Seeds used for the experiment
should not be dormant (other than physical dormancy).

According to the method of Bonn (in prep.), the simulation of ingestion and digestion
includes a mechanical treatment representing chewing and a chemical treatment standing
for seed digestion in the abomasum. For both control and simulation of digestion, five
replicate seed sets of each 150 seeds per species are used. The seeds are placed in
plastic lids ('Schnappdeckel', 75 mm x 28 mm) which are attached to a wooden board.
The seeds should completely cover the bottom of the lid (single layer); if seeds are too
large, several lids are used. An iron stick ('chewing stick', 1.3 m long) which is fitting
exactly in the plastic lids (contact area 2 $cm^2$, end padded with a thin layer of technical
fleece and covered with masking tape) is loaded with body weight ($\sim$70 kg) and rotated
90° laterally twice.

Afterwards, the 'chewed' seeds are placed in small glass tubes filled with HCl (0.1M) for
eight hours and washed with distilled water on a porcelain filter afterwards.

The survival rates are examined by comparing the germination rates of treated versus
untreated seeds (simulation vs. control). For both the simulation and the control, five sets
of 150 seeds each are put on two filter paper circles of 90 mm in diameter in transparent
plastic dishes. They are watered with distilled water and closed with parafilm-laboratory
film. The dishes are placed in a growth chamber with a 14 h light/22°C, 10 h dar-
kness/12°C climate regime for six weeks with seedlings being counted and removed once
a week. Viability of the remaining seeds is tested by pressing the seeds with a needle to
test if the embryo is firm (Bakker *et al*. 1996).

The data sheet for the input of measured data (see Data structure) will comprise the mean
and median percentage survival rate, the dispersal vector, N (number of replicates), the
standard deviation, the standard error, the minimum and the maximum as well as infor-
mation about the examined dispersal unit (according to the categories of the trait 'mor-
phology of dispersal unit').

**Minimal requirements**
The mean of the five replicate measurements, N (number of replicates), the standard deviation, the minimum and the maximum are given. Other obligate information concerns the state of the examined dispersal unit (seed or diaspore).
If less than 1500 seeds are available, the experiment can exceptionally be conducted with less seeds per replicate or with only 3 replicates.

**Data structure**
To collect:    In total 1500 seeds per species (150 seeds per replicate)
Obligate:
- Type of variable: numerical
- Sample size (n): 150
- Number of replicates (N): 10
- Unit: %
- Values: N, mean, median, minimum, maximum, standard deviation, standard error
- Seed structure: see Morphology of dispersal unit (Chapter 5.4)
- Diaspore type: see Morphology of dispersal unit (Chapter 5.4)
- Dispersal type: see Table 3.6 (Chapter 5.8)
- Dispersal vector: see Table 3.7 (Chapter 5.8)

Optional:    o   Comment field: Any information of importance to the trait

## 6.6. DISPERSAL DATA OBTAINED FROM LITERATURE

*C. Römermann, O. Tackenberg and P. Poschlod*

Seeds of most species are dispersed by means of several different dispersal vectors. In the literature, general information about the dispersal types as well as more specific information about the dispersal vectors are given and can be included in the LEDA Traitbase. For ecological questions it is not only essential to know in which way species are dispersed, but if they can be dispersed over long distances by the dispersal type or vector. Hence, in the Traitbase, every dispersal type and vector is classified as being capable of long-distance dispersal or not. When adding new dispersal vectors, additional information about the capability of long-distance dispersal is required. Hence water and wind dispersal in a broad sense can not be accepted as valid data entries, because they include dispersal types capable of long distance dispersal (meteorochory, nautochory) as well as dispersal types capable of short distance dispersal only (boleochory, ombrochory; see Table 3.6 and 3.7 for further details).

Generally, further information has to be linked to the data fields 'dispersal type' (Table 3.6) and 'dispersal vector' (Table 3.7) as every dispersal type or vector has to be described and assigned to the main dispersal type and to its capability of long-distance dispersal (LDD). Independent of the vectors` capability of long-distance dispersal, the dispersal potential demonstrates how well a species is dispersed by the relevant vector. Other data fields are in accordance to the general standards.

***Table 3.6.*** *Dispersal types and Main dispersal types with long distance dispersal (LDD) potential.*

| Dispersal type | Main dispersal type | LDD [1] | Explanation |
|---|---|---|---|
| Autochor | Autochor | no | Self dispersal |
| Ballochor | Autochor | no | Explosive mechanisms |
| Blastochor | Autochor | no | Autonomous placement of seeds or daughter plant away from mother plant |
| Chamaechor | Chamaechor | (yes) | Tumbleweeds; dispersal unit rolling over the soil surface caused by wind |
| Agochor | Hemerochor | yes | Unintended dispersal by man |
| Ethelochor | Hemerochor | yes | Dispersal by trading of plants or seeds |
| Hemerochor | Hemerochor | yes | Dispersal by man |
| Speirochor | Hemerochor | yes | Dispersal with seeds of agricultural species |
| Meteorochor | Anemochor | yes | Dispersal by wind (*Note*: flyers only, no tumbleweeds or wind-ballistics) |
| Nautochor | Nautochor | yes | Dispersal by surface currents of water |
| Ombrochor | Ombrochor | no | 'Raindrop-ballists': raindrops triggering ballistic seed dispersal |
| Dysochor | Zoochor | yes | Dispersal by scatter-hoarding animals |
| Endozoochor | Zoochor | yes | Dispersal after digestion |
| Epizoochor | Zoochor | yes | Adhesive dispersal |

[1] LDD: Long distance dispersal.

**Minimal requirements**

The method has to be given as it indicates the data quality ('unknown' as least reliable method).

**Data structure**

Obligate:
- Type of variable: numerical
- Values: N, mean, median, minimum %, maximum %, standard deviation, standard error
- Seed structure: see Morphology of dispersal unit (Chapter 5.4)
- Diaspore type: see Morphology of dispersal unit (Chapter 5.4)
- Dispersal type: see Table 3.6 (Chapter 5.8)
- Dispersal vector: see Table 3.7 (Chapter 5.8)

Optional:
- o Comment field: Any information of importance to the trait

**Table 3.7.** *Dispersal vectors and their categorisation into capability of long-distance dispersal (LDD).*

| Dispersal vector | LDD | ispersal vector | LDD |
|---|---|---|---|
| Ants | no | Mammals | yes |
| Birds | yes | Man | yes |
| Cattle | yes | Manure | yes |
| Chamois | yes | Marmot | no |
| Commerce | yes | Mouse | no |
| Seed contamination | yes | Ornamental plant | yes |
| Deer | yes | Rabbit | yes |
| Earthworms | no | Roe | yes |
| Fish | yes | Ruminants | yes |
| Flowing fresh water | yes | Shaken fresh water [1] | yes |
| Flowing salt water | yes | Shaken water with detergents [1] | yes |
| Goats | yes | Sheep | yes |
| Hay transport | yes | Squirrel | yes |
| Horses | yes | Standing fresh water | yes |
| Liquid manure | yes | Standing salt water | yes |
| Litter transport | yes | Wild boar | yes |

[1] Laboratorium experiments