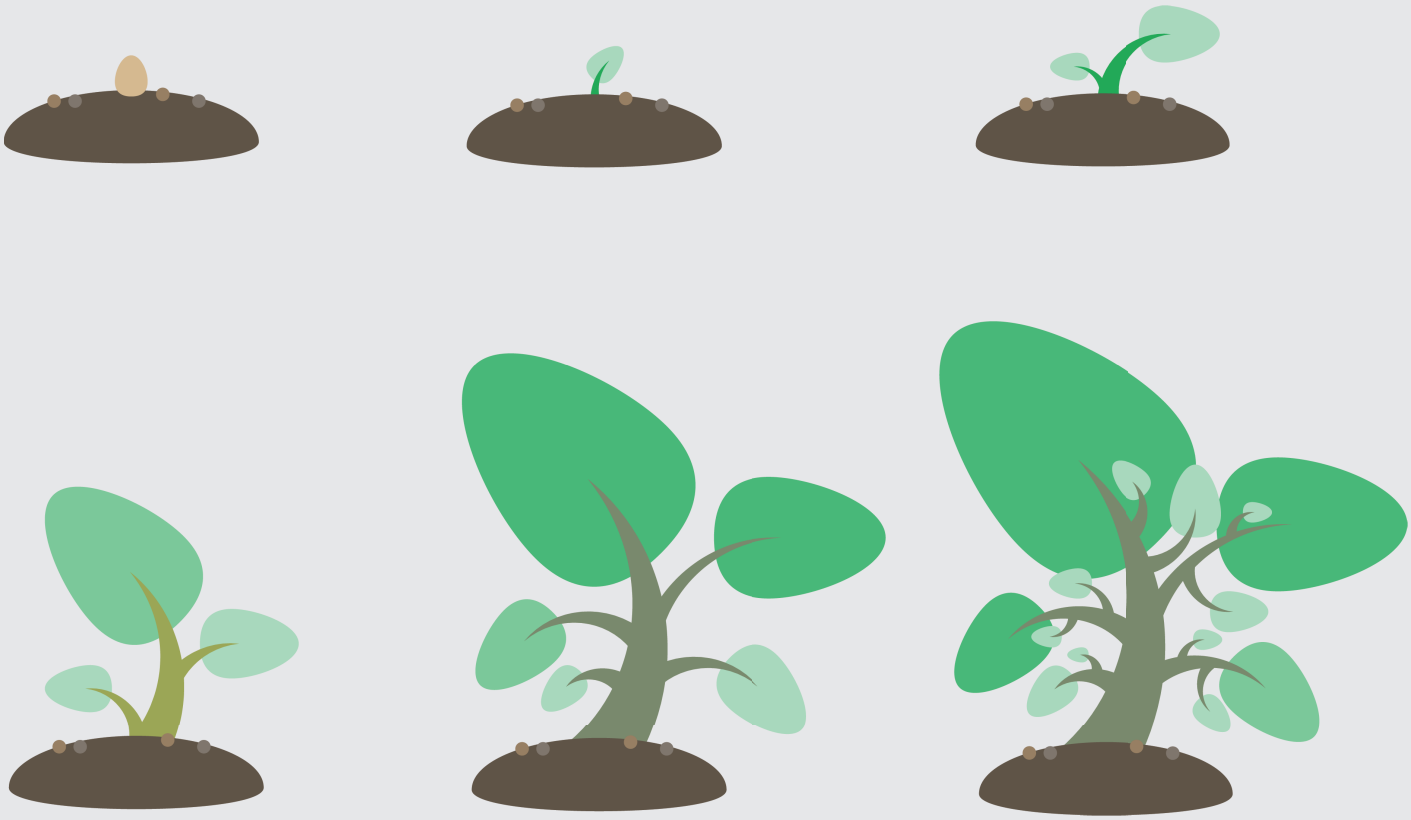
Growth stages
of mono- and dicotyledonous plants

BBCH
Monograph



Growth stages of mono- and dicotyledonous plants

BBCH Monograph

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The scientific content is identical. For better handling, the 1997 edition was digitalised, divided into four parts according to the respective language and newly assembled.

Related works:

Entwicklungsstadien mono- und dikotyler Pflanzen
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Foreword

As all branches of science, the individual disciplines in agricultural plant research also work more closely together, and, in addition, have become more international. The exchange of new findings and joint work on projects presuppose, however, that all those involved have the same understanding of the terms they use. This calls for standardised description of plant development stages in order of their phenological characteristics and their coding.

The phenological development stages of plants are also used in agricultural practice, agrometeorology and agricultural insurance, each with its own varying individual objectives. Moreover, the applied botanical sciences also make use of phenological development stages.

This book about plant development stages - and their corresponding codes - aims at satisfying all these demands. Of particular significance is the fact that the work appears in four languages and thus contributes to a large extent to reducing linguistic communication problems. It thus fulfils in a special way the intertwinement of research, trade, production and service present today.

The book owes its existence to the close co-operation between scientists from agricultural authorities, companies from the chemical industry and agricultural research departments. It is hoped that this fruitful co-operation, in the course of which knowledge has been gathered by all sides over many years, will contribute to furnishing decision makers with more security, and will promote international co-operation.

Prof. Dr. F. Klingauf
President of the Federal Biological Research Centre for Agriculture and Forestry, Berlin and Braunschweig

Note of Thanks

This book was made possible by a joint initiative of the Institute for Vegetables and Ornamentals in Großbeeren/Erfurt (IGZ), the German Federal Office of Plant Varieties (BSA), the concerns Hoechst-Schering Agrevo GmbH, Bayer AG, BASF AG and Novartis AG, the German Agrochemical Association (IVA) and the German Federal Biological Research Centre for Agriculture and Forestry (BBA). Not only have these institutions and concerns provided substantial funds, but also scientific and technical employees, whose joint work over several years has made this book possible. Indispensable however has been the work of numerous cooperating scientists and co-authors who have enabled the description of the development stages of the crops with their crop specific knowledge. 1 would like to thank them at this point for their help.

An essential aim of this book is to facilitate scientific communication on an international level. Fortunately I was able to find specialist translators . The Spanish translations were done by Mr. Enrique Gonzales Medina, Bogotá / Kolumbien, Mr. José Antonio Guerra, Ciba, Barcelona, as well as Dr. Herrman Bleiholder, BASF AG, who earns the credit for unifying versions in the Spanish language from South America and Spain. The French text was translated by Mrs. Sibyl Rometsch, Institute de Botanique Systematique et de Geobotanique, Universite de Lausanne. The English text was corrected by Dr. P. D. Lancashire, Bayer, Bury St. Edmunds, UK.

Mr. Ernst Halwaß from Nossen agreed as commercial artist to produce the main part of the graphical representations, enabling the clear visual portrayal of the important development stages of the particular crops. Thanks go to him for the creation of drawings of all vegetable plants, for pome fruit, stone fruit, currant, strawberry, and those of the beet, potato, cotton, peanut, hop, faba bean, sunflower, maize, soybean and grapevine. Thanks also to Mr. Tottman and Mrs. Broad for their drawings of cereals.

The authors would also like to thank those colleagues who carried out the necessary technical work with so much patience and perseverance.

The production of a book in this form requires substantial financial means. We would therefore like to thank the following companies and institutions at this point for the financial resources provided: Hoechst-Schering Agrevo GmbH, BASF AG, Bayer AG, Novartis AG, Dow Elanco, Du Pont de Nemours, Rhône-Poulenc Agro, Zeneca and the German Agrochemical Association (IVA).

Uwe Meier

I Phenological growth stages for mono- and dicotyledonous plants

- Uniform codation of the extended BBCH-scale -

Members of the working group: Hermann Bleiholder, Limburgerhof • Liselotte Buhr, Kleinmachnow • Carmen Feller, Grossbeeren •Helmut Hack, Odenthal •Martin Hess, Frankfurt • Renate Klose, Hannover • Peter D. Lancashire, Bury St. Edmunds • Uwe Meier, Braunschweig • Reinhold Stauss, Kiel • Theo van den Boom, Leverkusen • Elfriede Weber, Limburgerhof

With 28 graphics

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Entwicklungsstadien mono- und dikotyler Pflanzen
Estadios de las Plantas mono- Y dicotiledoneas
Stades phenologiques des Mono- et Dicotyledones cultivees
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1 The extended BBCH-scale,
Hack et al., 1992

The extended BBCH-scale is a system for a uniform coding of phenologically similar growth stages of all mono- and dicotyledonous plant species. It results from teamwork between the German Federal Biological Research Centre for Agriculture and Forestry (BBA), the German Federal Office of Plant Varieties (BSA), the German Agrochemical Association (IVA) and the Institute for Vegetables and Ornamentals in Grossbeeren/Erfurt, Germany (IGZ). The decimal code, which is divided into principal and secondary growth stages, is based on the well-known cereal code developed by ZADOKS et al. (1974) in order to avoid major changes from this widely used phenological key.The abbreviation BBCH derives from **B**iologische Bundesanstalt, **B**undessortenamt and **CH**emical industry.

1.1 The basic principles of the scale

- The **general scale** forms the framework within which the individual scales are developed. It can also be used for those plant species for which no special scale is currently available.
- Similar phenological stages of each plant species are given the same code.
- For each code, a description is given, and for some important stages, drawings are included.
- For the description of the phenological development stages, clear and easily recognised (external) morphological characteristics are used.
- Except where stated otherwise, only the development of the main stem is taken into consideration.
- The growth stages refer to representative individual plants within the crop stand. Crop stand characteristics may also be considered.
- Relative values relating to species- and/or variety-specific ultimate sizes are used for the indication of sizes.
- The secondary growth stages 0 to 8 correspond to the respective ordinal numbers or percentage values. For example stage 3 could represent: 3rd true leaf, 3rd tiller, 3rd node or 30 % of the final length or size typical of the species or 30 % of the flowers open.
- Post harvest or storage treatment is coded **99**.
- Seed treatment before planting is coded **00**.

Organisation of the scale

The entire developmental cycle of the plants is subdivided into ten clearly recognizable and distinguishable longer-lasting developmental phases. These **principal growth stages** are described using numbers from 0 to 9 in ascending order (see Figures 1a and b). The principal growth stages are described in Table 1. Owing to the very many different plant species there may be shifts in the course of the development or certain stages may even be omitted.

The principal growth stages need not proceed in the strict sequence defined by the ascending order of the figures, but can occasionally also proceed in parallel.

Table 1: Principal growth stages

Stage	Description
0	Germination / sprouting / bud development
1	Leaf development (main shoot)
2	Formation of side shoots / tillering
3	Stem elongation or rosette growth / shoot development (main shoot)
4	Development of harvestable vegetative plant parts or vegetatively propagated organs / booting (main shoot)
5	Inflorescence emergence (main shoot) / heading
6	Flowering (main shoot)
7	Development of fruit
8	Ripening or maturity of fruit and seed
9	Senescence, beginning of dormancy

If two or more principal growth stages proceed in parallel, both can be indicated by using a diagonal stroke (example 16/22). If only one stage is to be indicated, either the more advanced growth stage must be chosen or the principal growth stage of particular interest, depending upon the plant species.

The principal growth stages alone are not sufficient to define exactly application or evaluation dates, since they always describe **time spans** in the course of the development of a plant.

Secondary stages are used if **points of time** or steps in the plant development must be indicated precisely. In contrast to the principal growth stages they are defined as short developmental steps characteristic of the respective plant species, which are passed successively during the respective principal growth stage. They are also coded by using the figures 0 to 9. The combination of figures for the principal and the secondary stages, results in the two-digit code.

The two-digit code is a scale which offers the possibility of precisely defining all phenological growth stages for the majority of plant species.

Only in the case of some plant species (e.g. cucumber, onion, potato, tomato) is further subdivision necessary within a principal growth stage beyond that possible using the secondary stages from 0 to 9.

For these cases a three-digit scale is presented alongside the two-digit scale. This involves the inclusion of the so-called **mesostage** between the principal and the secondary stage, which provides a further subdivision with figures **0** and **1** describing the development on the **main stem** and figures **2** to **9** that of the side shoots **2nd** to **9th order** (see Figures 1a and b). In this way up to 19 leaves can be counted on the main stem or the branching can be described.

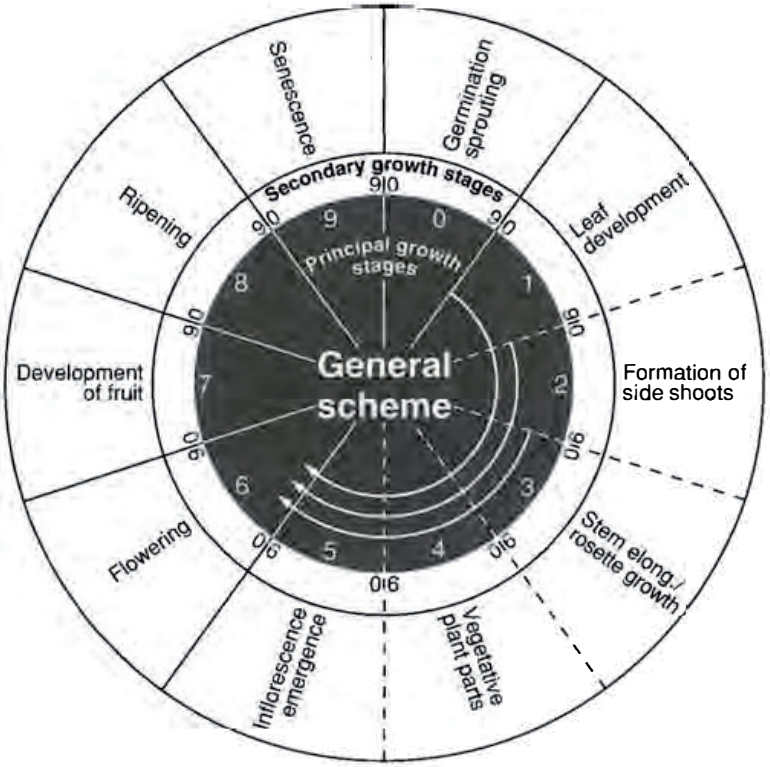
The BBCH-scales allow the comparison of individual codes only within one principal growth stage: an arithmetically greater code indicates a plant at a later growth stage. Sorting codes into numerical order therefore allows a listing in order of the stage of plant development.

The time span of certain developmental phases of a plant can be exactly defined and coded by indicating two stages. For this purpose two codes are connected with a hyphen. Thus, for instance, the code 51 - 69 describes the developmental phase from the appearance of the first inflorescence or flower buds until the end of flowering. This allows the computer-supported monitoring of crop stands.

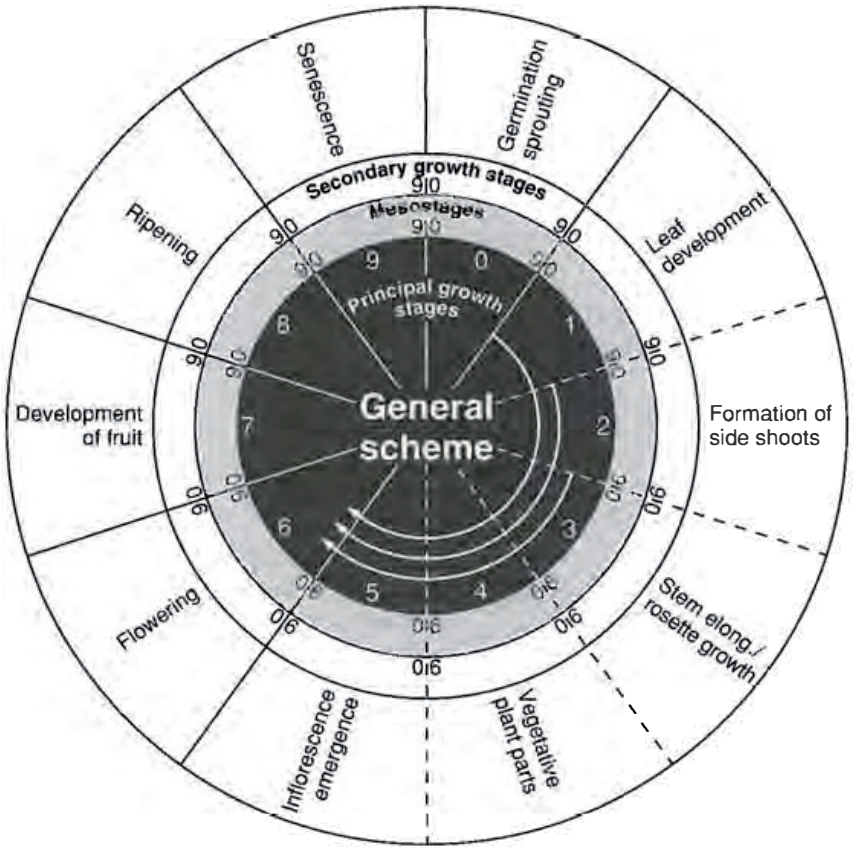
For a uniform coding which covers the maximum number of plant species, it is necessary to use primarily phenological criteria rather than homologous or analogous stages. Thus, for instance, germination of plants from true seed and sprouting from buds are classified in one principal growth stage, the principal growth stage 0, even though they are completely different biological processes.

In case of the BBCH-scales the descriptions are based on the actual characteristic features of the individual plant. If the scales are used for the definition of the development stage of a plant stand, the description should apply to at least 50 % of the plants.

Greater differences in the course of the development of different plant groups have to be taken into consideration for the description of the general scale (see 1.2). This problem is dealt with by offering several definitions for one specific stage wherever the formulation of a uniform text is impossible. The following letters show to which plant group the respective definition refers.



a



b

Figures 1a and b. Subdivision of the developmental cycle of plants into principal and secondary stages (a) and into principal, meso- and secondary stages (b). The mesostages are inserted between the principal and the secondary stages. Modified according to a draft by A. Witzenberger.

1.2 The extended BBCH-scale, general

D = **D**icotyledons **G** = **G**ramineae

M = **M**onocotyledons **P** = **P**erennial plants

V = Development from **v**egetative parts or propagated organs.

No code letter is used if the description applies to all groups of plants.

Principal growth stage 0: Germination, sprouting, bud development

00		Dry seed (seed dressing takes place at stage 00)
	P, V	Winter dormancy or resting period
01		Beginning of seed imbibition;
	P, V	Beginning of bud swelling
02		
03		Seed imbibition complete;
	P, V	End of bud swelling
04		
05		Radicle (root) emerged from seed;
	P, V	Perennating organs forming roots
06		Elongation of radicle, formation of root hairs and/or lateral roots
07	G	Coleoptile emerged from caryopsis;
	D, M	Hypocotyl with cotyledons or shoot breaking through seed coat;
	P, V	Beginning of sprouting or bud breaking
08	D	Hypocotyl with cotyledons growing towards soil surface;
	P, V	Shoot growing towards soil surface
09	G	*Emergence:* Coleoptile breaks through soil surface;
	D, M	*Emergence:* Cotyledons break through soil surface (except hypogeal germination);
	D, V	*Emergence:* Shoot/leaf breaks through soil surface;
	P	Bud shows green tips

Principal growth stage 1: Leaf development (main shoot)

10	G	First true leaf emerged from coleoptile;
	D, M	Cotyledons completely unfolded;
	P	First leaves separated
11		First true leaf, leaf pair or whorl unfolded;
	P	First leaves unfolded
12		2 true leaves, leaf pairs or whorls unfolded
13		3 true leaves, leaf pairs or whorls unfolded
1 .		Stages continuous till ...
19		9 or more true leaves, leaf pairs or whorls unfolded

Principal growth stage 2: Formation of side shoots/tillering

20		-
21		First side shoot visible;
	G	First tiller visible
22		2 side shoots visible;
	G	2 tillers visible
23		3 side shoots visible;
	G	3 tillers visible
2 .		Stages continuous till . . .
29		9 or more side shoots visible;
	G	9 or more tillers visible

Principal growth stage 3: Stem elongation or rosette growth, shoot development (main shoot)

30		-
31		Stem (rosette) 10 % of final length (diameter);
	G	1 node detectable
32		Stem (rosette) 20 % of final length (diameter);
	G	2 nodes detectable
33		Stem (rosette) 30 % of final length (diameter);
	G	3 nodes detectable
3 .		Stages continuous till...
39		Maximum stem length or rosette diameter reached;
	G	9 or more nodes detectable

Principal growth stage 4: Development of harvestable vegetative plant parts or vegetatively propagated organs/booting (main shoot)

40		Harvestable vegetative plant parts or vegetatively propagated organs begin to develop
41	G	Flag leaf sheath extending
42		-
43		Harvestable vegetative plant parts or vegetatively propagated organs have reached 30 % of final size;
	G	Flag leaf sheath just visibly swollen (mid-boot)
44		-
45		Harvestable vegetative plant parts or vegetatively propagated organs have reached 50 % of final size;
	G	Flag leaf sheath swollen (late-boot)
46		-
47		Harvestable vegetative plant parts or vegetatively propagated organs have reached 70 % of final size;
	G	Flag leaf sheath opening
48		-
49		Harvestable vegetative plant parts or vegetatively propagated organs have reached final size;
	G	First awns visible

Principal growth stage 5: Inflorescence emergence (main shoot)/heading

50		-
51		Inflorescence or flower buds visible;
	G	Beginning of heading
52		-
53		-
54		-
55		First individual flowers visible (still closed);
	G	Half of inflorescence emerged (middle of heading)
56		-
57		-
58		-
59		First flower petals visible (in petalled forms);
	G	Inflorescence fully emerged (end of heading)

Principal growth stage 6: Flowering (main shoot)

60	First flowers open (sporadically)
61	Beginning of flowering: 10 % of flowers open
62	20 % of flowers open
63	30 % of flowers open
64	40 % of flowers open
65	Full flowering: 50 % of flowers open, first petals may be fallen
66	-
67	Flowering finishing: majority of petals fallen or dry
68	-
69	End of flowering: fruit set visible

Principal growth stage 7: Development of fruit

70		-
71		10 % of fruits have reached final size or fruit has reached 10 % of final size [1]
	G	Caryopsis watery ripe
72		20 % of fruits have reached final size or fruit has reached 20 % of final size [1]
73		30 % of fruits have reached final size or fruit has reached 30 % of final size [1]
	G	Early milk
74		40 % of fruits have reached final size or fruit has reached 40 % of final size [1]
75		50 % of fruits have reached final size or fruit has reached 50 % of final size [1]
	G	Milky ripe, medium milk

[1] *This stage is not used, if the main fruit growth happens in principal growth stage 8*

Principal growth stage 7: Development of fruit (continuation)

76		60 % of fruits have reached final size or fruit has reached 60 % of final size [1]
77		70 % of fruits have reached final size or fruit has reached 70 % of final size [1]
	G	Late milk
78		80 % of fruits have reached final size or fruit has reached 80 % of final size [1]
79		Nearly all fruits have reached final size [1]

Principal growth stage 8: Ripening or maturity of fruit and seed

80		-
81		Beginning of ripening or fruit colouration
82		-
83		-
84		-
85		Advanced ripening or fruit colouration;
	G	Dough stage
86		-
87		Fruit begins to soften (species with fleshy fruit)
88		-
89		Fully ripe: fruit shows fully-ripe colour, beginning of fruit abscission

Principal growth stage 9: Senescence, beginning of dormancy

90		-
91	P	Shoot development completed, foliage still green
92		-
93		Beginning of leaf-fall
94		-
95		50 % of leaves fallen
96		-
97		End of leaf fall, plants or above ground parts dead or dormant;
	P	Plant resting or dormant
98		-
99		Harvested product (post-harvest or storage treatment is applied at stage 99)

[1] *This stage is not used, if the main fruit growth happens in principal growth stage 8*

1.3 The extended BBCH-scale, for specific crops

1.3.1 Phenological growth stages and BBCH-identification keys of cereals (wheat = *Triticum* sp. L., barley = *Hordeum vulgare* L., oat = *Avena sativa* L., rye = *Secale cereale* L.), Witzenberger et al., 1989; Lancashire et al., 1991

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development** [1, 2]	
00	Dry seed (caryopsis)	10	First leaf through coleoptile
01	Beginning of seed imbibition	11	First leaf unfolded
02	-	12	2 leaves unfolded
03	Seed imbibition complete	13	3 leaves unfolded
04	-	1 .	Stages continuous till ...
05	Radicle emerged from caryopsis	19	9 or more leaves unfolded
06	Radicle elongated, root hairs and/or side roots visible		
07	Coleoptile emerged from caryopsis		
08	-		
09	Emergence: coleoptile penetrates soil surface (cracking stage)		

[1] *A leaf is unfolded when its ligule is visible or the tip of the next leaf is visible*

[2] *Tillering or stem elongation may occur earlier than stage 13; in this case continue with stages 21*

Code	Description
Principal growth stage 2: Tillering [3]	
20	No tillers
21	Beginning of tillering: first tiller detectable
22	2 tillers detectable
23	3 tillers detectable
2 .	Stages continuous till ...
29	End of tillering. Maximum no. of tillers detectable

Code	Description
Principal growth stage 3: Stem elongation	
30	Beginning of stem elongation: pseudostem and tillers erect, first internode begins to elongate, top of inflorescence at least 1 cm above tillering node
31	First node at least 1 cm above tillering node
32	Node 2 at least 2 cm above node 1
33	Node 3 at least 2 cm above node 2
3 .	Stages continuous till ...
37	Flag leaf just visible, still rolled
38	
39	Flag leaf stage: flag leaf fully unrolled, ligule just visible

[3] *If stem elongation begins before the end of tillering continue with stage 30*

Code	Description	Code	Description
Principal growth stage 4: Booting		**Principal growth stage 5: Inflorescence emergence, heading**	
40	-	50	-
41	Early boot stage: flag leaf sheath extending	51	Beginning of heading: tip of inflorescence emerged from sheath, first spikelet just visible
42	-	52	20 % of inflorescence emerged
43	Mid boot stage: flag leaf sheath just visibly swollen	53	30 % of inflorescence emerged
44	-	54	40 % of inflorescence emerged
45	Late boot stage: flag leaf sheath swollen	55	Middle of heading: half of inflorescence emerged
46	-	56	60 % of inflorescence emerged
47	Flag leaf sheath opening	57	70 % of inflorescence emerged
48	-	58	80 % of inflorescence emerged
49	First awns visible (in awned forms only)	59	End of heading: inflorescence fully emerged

Code	Description	Code	Description
Principal growth stage 6: Flowering, anthesis		**Principal growth stage 7: Development of fruit**	
60	-	70	-
61	Beginning of flowering: first anthers visible	71	Watery ripe: first grains have reached half their final size
62	-	72	-
63	-	73	Early milk
64	-	74	-
65	Full flowering: 50 % of anthers mature	75	Medium milk: grain content milky, grains reached final size, still green
66	-	76	-
67	-	77	Late milk
68	-	78	-
69	End of flowering: all spikelets have completed flowering but some dehydrated anthers may remain	79	-

Code	Description	Code	Description
Principal growth stage 8: Ripening		**Principal growth stage 9: Senescence**	
80	-	90	-
81	-	91	-
82	-	92	Over-ripe: grain very hard, cannot be dented by thumbnail
83	Early dough	93	Grains loosening in day-time
84	-	94	-
85	Soft dough: grain content soft but dry. Fingernail impression not held	95	-
86	-	96	-
87	Hard dough: grain content solid. Fingernail impression held	97	Plant dead and collapsing
88	-	98	-
89	Fully ripe: grain hard, difficult to divide with thumbnail	99	Harvested product

1.3.2 Phenological growth stages and BBCH-identification keys of rice (*Oryza sativa* L.), Lancashire et al., 1991

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development** [1, 2]	
00	Dry seed (caryopsis)	10	Imperfect leaf unrolled, tip of first true leaf visible
01	Beginning of seed imbibition	11	First leaf unfolded
02	-	12	2 leaves unfolded
03	Seed imbibition complete (pigeon breast)	13	3 leaves unfolded
04	-	1 .	Stages continuous till ...
05	Radicle emerged from caryopsis	19	9 or more leaves unfolded
06	Radicle elongated, root hairs and/or side roots visible		
07	Coleoptile emerged from caryopsis (in water-rice this stage occurs before stage 05)		
08	-		
09	Imperfect leaf emerges (still rolled) at the tip of the coleoptile		

[1] *A leaf is unfolded when its ligule is visible or the tip of the next leaf is visible*

[2] *Tillering or stem elongation may occur earlier than stage 13; in this case continue with stages 21 or 30*

Code	Description
Principal growth stage 2: Tillering [3]	
20	-
21	Beginning of tillering: first tiller detectable
22	2 tillers detectable
23	3 tillers detectable
2 .	Stages continuous till ...
29	Maximum number of tillers detectable

Code	Description
Principal growth stage 3: Stem elongation	
30	Panicle initiation or green ring stage: chlorophyll accumulates in the stem tissue, forming a green ring
31	-
32	Panicle formation: panicle 1 - 2 mm in length
33	-
34	Internode elongation or jointing stage: internodes begin to elongate, panicle more than 2 mm long (variety-dependent)
35	-
36	-
37	Flag leaf just visible, still rolled, panicle moving upwards
38	-
39	Flag leaf stage: flag leaf unfolded, collar regions (auricle and ligule) of flag leaf and penultimate leaf aligned (pre-boot stage)

[3] *If stem elongation begins before the end of tillering continue with stage 30*

Code	Description	Code	Description
Principal growth stage 4: Booting		**Principal growth stage 5: Inflorescence emergence, heading** [4]	
40	-	50	-
41	Early boot stage: upper part of stem slightly thickened, sheath of flag leaf about 5 cm out of penultimate leaf sheath	51	Beginning of panicle emergence: tip of inflorescence emerged from sheath
42	-	52	20 % of panicle emerged
43	Mid boot stage: sheath of flag leaf 5 - 10 cm out of the penultimate leaf sheath	53	30 % of panicle emerged
44	-	54	40 % of panicle emerged
45	Late boot stage: flag leaf sheath swollen, sheath of flag leaf more than 10 cm out of penultimate leaf sheath	55	Middle of panicle emergence: neck node still in sheath
46	-	56	60 % of panicle emerged
47	Flag leaf sheath opening	57	70 % of panicle emerged
48	-	58	80 % of panicle emerged
49	Flag leaf sheath open	59	End of panicle emergence: neck node level with the flag leaf auricle, anthers not yet visible

[4] *Flowering usually starts before stage 55; continue with principal stage 6*

Code	Description	Code	Description
Principal growth stage 6: Flowering, anthesis		**Principal growth stage 7: Development of fruit**	
60	-	70	-
61	Beginning of flowering: anthers visible at top of panicle	71	Watery ripe: first grains have reached half their final size
62	-	72	-
63	-	73	Early milk
64	-	74	-
65	Full flowering: anthers visible on most spikelets	75	Medium milk: grain content milky
66	-	76	-
67	-	77	Late milk
68	-	78	-
69	End of flowering: all spikelets have completed flowering but some dehydrated anthers may remain	79	-

Code	Description	Code	Description
Principal growth stage 8: Ripening		**Principal growth stage 9: Senescence**	
80	-	90	-
81	-	91	-
82	-	92	Over-ripe: grain very hard, cannot be dented by thumbnail
83	Early dough	93	-
84	-	94	-
85	Soft dough: grain content soft but dry, fingernail impression not held, grains and glumes still green	95	-
86	-	96	-
87	Hard dough: grain content solid, fingernail impression held	97	Plant dead and collapsing
88	-	98	-
89	Fully ripe: grain hard, difficult to divide with thumbnail	99	Harvested product

1.3.3 Phenological growth stages and BBCH-identification keys of maize (*Zea mays* L.), Weber and Bleiholder, 1990; Lancashire et al., 1991

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development** [1, 2]	
00	Dry seed (caryopsis)	10	First leaf through coleoptile
01	Beginning of seed imbibition	11	First leaf unfolded
02	-	12	2 leaves unfolded
03	Seed imbibition complete	13	3 leaves unfolded
04	-	1 .	Stages continuous till ...
05	Radicle emerged from caryopsis	19	9 or more leaves unfolded
06	Radicle elongated, root hairs and/or side roots visible		
07	Coleptile emerged from caryopsis		
08	-		
09	Emergence: coleoptile penetrates soil surface (cracking stage)		

[1] *A leaf may be described as unfolded when its ligule is visible or the tip of next leaf is visible*
[2] *Tillering or stem elongation may occur earlier than stage 19; in this case continue with principal growth stage 3*

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Stem elongation	
30	Beginning of stem elongation
31	First node detectable
32	2 nodes detectable
33	3 nodes detectable
3 .	Stages continuous till ...
39	9 or more nodes detectable [3]

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence, heading	
50	-
51	Beginning of tassel emergence: tassel detectable at top of stem
52	-
53	Tip of tassel visible
54	-
55	Middle of tassel emergence: middle of tassel begins to separate
56	-
57	-
58	-
59	End of tassel emergence: tassel fully emerged and separated

[3] *In maize, tassel emergence may occur earlier; in this case continue with principal growth stage 5*

Code	Description	Code	Description
Principal growth stage 6: Flowering, anthesis		**Principal growth stage 7: Development of fruit**	
60	-	70	-
61	Male: stamens in middle of tassel visible Female: tip of ear emerging from leaf sheath	71	Beginning of grain development: kernels at blister stage, about 16 % dry matter
62	-	72	-
63	Male: beginning of pollen shedding Female: tips of stigmata visible	73	Early milk
64	-	74	-
65	Male: upper and lower parts of tassel in flower Female: stigmata fully emerged	75	Kernels in middle of cob yellowish-white (variety-dependent), content milky, about 40 % dry matter
66	-	76	-
67	Male: flowering completed Female: stigmata drying	77	-
68	-	78	-
69	End of flowering: stigmata completely dry	79	Nearly all kernels have reached final size

Maize

Code	Description	Code	Description
Principal growth stage 8: Ripening		**Principal growth stage 9: Senescence**	
80	-	90	-
81	-	91	-
82	-	92	-
83	Early dough: kernel content soft, about 45 % dry matter	93	-
84	-	94	-
85	Dough stage: kernels yellowish to yellow (variety dependent), about 55 % dry matter	95	-
86	-	96	-
87	Physiological maturity: black dot/layer visible at base of kernels, about 60 % dry matter	97	Plant dead and collapsing
88	-	98	-
89	Fully ripe: kernels hard and shiny, about 65 % dry matter	99	Harvested product

1.3.4 Phenological growth stages and BBCH-identification keys of oilseed rape (*Brassica napus* L. ssp. *napus*), Weber and Bleiholder, 1990; Lancashire et al., 1991

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development** [1]	
00	Dry seed	10	Cotyledons completely unfolded
01	Beginning of seed imbibition	11	First leaf unfolded
02	-	12	2 leaves unfolded
03	Seed imbibition complete	13	3 leaves unfolded
04	-	1 .	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more leaves unfolded
06	-		
07	Hypocotyl with cotyledons emerged from seed		
08	Hypocotyl with cotyledons growing towards soil surface		
09	Emergence: cotyledons emerge through soil surface		

[1] *Stem elongation may occur earlier than stage 19; in this case continue with stage 20*

Oilseed rape

Code	Description	Code	Description
Principal growth stage 2: Formation of side shoots		**Principal growth stage 3: Stem elongation** [2]	
20	No side shoots	30	Beginning of stem elongation: no internodes ('rosette')
21	Beginning of side shoot development: first side shoot detectable	31	1 visibly extended internode
22	2 side shoots detectable	32	2 visibly extended internodes
23	3 side shoots detectable	33	3 visibly extended internodes
2 .	Stages continuous till ...	3 .	Stages continuous till ...
29	End of side shoot development: 9 or more side shoots detectable	39	9 or more visibly extended internodes

[2] *Visibly extended internode n develops between leaf n and leaf n + 1*

Oilseed rape

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	Flower buds present, still enclosed by leaves
51	Flower buds visible from above ("green bud")
52	Flower buds free, level with the youngest leaves
53	Flower buds raised above the youngest leaves
54	-
55	Individual flower buds (main inflorescence) visible but still closed
56	-
57	Individual flower buds (secondary inflorescences) visible but still closed
58	-
59	First petals visible, flower buds still closed ("yellow bud")

Code	Description
Principal growth stage 6: Flowering	
60	First flowers open
61	10 % of flowers on main raceme open, main raceme elongating
62	20 % of flowers on main raceme open
63	30 % of flowers on main raceme open
64	40 % of flowers on main raceme open
65	Full flowering: 50 % flowers on main raceme open, older petals falling
66	-
67	Flowering declining: majority of petals fallen
68	-
69	End of flowering

Oilseed rape

Code	Description	Code	Description
Principal growth stage 7: Development of fruit		**Principal growth stage 8: Ripening**	
70		80	Beginning of ripening: seed green, filling pod cavity
71	10 % of pods have reached final size	81	10 % of pods ripe, seeds dark and hard
72	20 % of pods have reached final size	82	20 % of pods ripe, seeds dark and hard
73	30 % of pods have reached final size	83	30 % of pods ripe, seeds dark and hard
74	40 % of pods have reached final size	84	40 % of pods ripe, seeds dark and hard
75	50 % of pods have reached final size	85	50 % of pods ripe, seeds dark and hard
76	60 % of pods have reached final size	86	60 % of pods ripe, seeds dark and hard
77	70 % of pods have reached final size	87	70 % of pods ripe, seeds dark and hard
78	80 % of pods have reached final size	88	80 % of pods ripe, seeds dark and hard
79	Nearly all pods have reached final size	89	Fully ripe: nearly all pods ripe, seeds dark and hard

Oilseed rape

Code	Description
Principal growth stage 9: Senescence	
90	-
91	-
92	-
93	-
94	-
95	-
96	-
97	Plant dead and dry
98	-
99	Harvested product

1.3.5 Phenological growth stages and BBCH-identification keys of faba bean (*Vicia faba* L.), Weber and Bleiholder, 1990; Lancashire et al., 1991

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development** [1]	
00	Dry seed	10	Pair of scale leaves visible (may be eaten or lost)
01	Beginning of seed imbibition	11	First leaf unfolded
02	-	12	2 leaves unfolded
03	Seed imbibition complete	13	3 leaves unfolded
04	-	1.	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more leaves unfolded
06	-		
07	Shoot emerged from seed (plumule apparent)		
08	Shoot growing towards soil surface		
09	Emergence: shoot emerges through soil surface		

[1] *Stem elongation may occur earlier than stage 19; in this case continue with the principal stage 3*

Faba bean

Code	Description	Code	Description
Principal growth stage 2: Formation of side shoots		***Principal growth stage 3: Stem elongation***	
20	No side shoots	30	Beginning of stem elongation
21	Beginning of side shoot development: first side shoot detectable	31	One visibly extended internode [2]
22	2 side shoots detectable	32	2 visibly extended internodes
23	3 side shoots detectable	33	3 visibly extended internodes
2 .	Stages continuous till ...	3 .	Stages continuous till ...
29	End of side shoot development: 9 or more side shoots detectable	39	9 or more visibly extended internodes

[2] *First internode extends from the scale leaf node to the first true leaf node*

Faba bean

Code	Description
Principal growth stage 4: ———	
Principal growth stage 5: Inflorescence emergence	
50	Flower buds present, still enclosed by leaves
51	First flower buds visible outside leaves
52	-
53	-
54	-
55	First individual flower buds visible outside leaves but still closed
56	-
57	-
58	-
59	First petals visible, many individual flower buds, still closed
Principal growth stage 6: Flowering	
60	First flowers open
61	Flowers open on first raceme
62	-
63	Flowers open 3 racemes per plant
64	-
65	Full flowering: flowers open on 5 racemes per plant
66	-
67	Flowering declining
68	-
69	End of flowering

Code	Description
Principal growth stage 7: Development of fruit	
70	First pods have reached final length („flat pod")
71	10 % of pods have reached final length
72	20 % of pods have reached final length
73	30 % of pods have reached final length
74	40 % of pods have reached final length
75	50 % of pods have reached final length
76	60 % of pods have reached final length
77	70 % of pods have reached final length
78	80 % of pods have reached final length
79	Nearly all pods have reached final length
Principal growth stage 8: Ripening	
80	Beginning of ripening: seed green, filling pod cavity
81	10 % of pods ripe, seeds dry and hard
82	20 % of pods ripe, seeds dry and hard
83	30 % of pods ripe and dark, seeds dry and hard
84	40 % of pods ripe and dark, seeds dry and hard
85	50 % of pods ripe and dark, seeds dry and hard
86	60 % of pods ripe and dark, seeds dry and hard
87	70 % of pods ripe and dark, seeds dry and hard
88	80 % of pods ripe and dark, seeds dry and hard
89	Fully ripe: nearly all pods dark, seeds dry and hard

Faba bean

Code	Description
Principal growth stage 9: Senescence	
90	-
91	-
92	-
93	Stems begin to darken
94	-
95	50 % of stems brown or black
96	-
97	Plant dead and dry
98	-
99	Harvested product

1.3.6 Phenological growth stages and BBCH-identification keys of sunflower (*Helianthus annuus* L.), Weber and Bleiholder, 1990; Lancashire et al., 1991

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development** [1]	
00	Dry seed (achene)	10	Cotyledons completely unfolded
01	Beginning of seed imbibition	11	-
02	-	12	2 leaves (first pair) unfolded
03	Seed imbibition complete	13	-
04	-	14	4 leaves (second pair) unfolded
05	Radicle emerged from seed	15	5 leaves unfolded
06	Radicle elongated, root hairs developing	16	6 leaves unfolded
07	Hypocotyl with cotyledons emerged from seed	17	7 leaves unfolded
08	Hypocotyl with cotyledons growing towards soil surface	18	8 leaves unfolded
09	Emergence: cotyledons emerge through soil surface	19	9 or more leaves unfolded

[1] *Stem elongation may occur earlier then stage 19; in this case continue with the principal stage 3*

Sunflower

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Stem elongation	
30	Beginning of stem elongation
31	1 visibly extended internode
32	2 visibly extended internodes
33	3 visibly extended internodes
3 .	Stages continuous till ...
39	9 or more visibly extended internodes

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	Inflorescence just visible between youngest leaves
52	-
53	Inflorescence separating from youngest leaves, bracts distinguishable from foliage leaves
54	-
55	Inflorescence separated from youngest foliage leaf
56	-
57	Inflorescence clearly separated from foliage leaves
58	-
59	Ray florets visible between the bracts; inflorescence still closed

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	-	70	-
61	Beginning of flowering: ray florets extended, disc florets visible in outer third of inflorescence	71	Seeds on outer edge of the inflorescence are grey and have reached final size
62	-	72	-
63	Disc florets in outer third of inflorescence in bloom (stamens and stigmata visible)	73	Seeds on outer third of the inflorescence are grey and have reached final size
64	-	74	-
65	Full flowering: disc florets in middle third of inflorescence in bloom (stames and stigmata visible)	75	Seeds on middle third of the inflorescence are grey and have reached final size
66	-	76	-
67	Flowering declining: disc florets in inner third of inflorescence in bloom (stames and stigmata visible)	77	-
68	-	78	-
69	End of flowering: most disc florets have finished flowering, ray florets dry or fallen	79	Seeds on inner third of the inflorescence are grey and have reached final size

Sunflower

Code	Description	Code	Description
Principal growth stage 8: Ripening		**Principal growth stage 9: Senescence**	
80	Beginning of ripening: seeds on outer third of anthocarp black and hard. Back of anthocarp still green	90	-
81	Seeds on outer third of anthocarp dark and hard. Back of anthocarp still green	91	-
82	-	92	Over ripe, seeds over 90 % dry matter
83	Dark of anthocarp yellowish-green, bracts still green. Seeds about 50 % dry matter	93	-
84	-	94	-
85	Seeds on middle third of anthocarp dark and hard. Back of anthocarp yellow, bracts brown edged. Seeds about 60 % dry matter	95	-
86	-	96	-
87	Physiological ripeness: back of the anthocarp yellow. Bracts marbled brown. Seeds about 75 - 80 % dry matter	97	Plant dead and dry
88	-	98	-
89	Fully ripe: seeds on inner third of anthocarp dark and hard. Back of anthocarp brown. Bracts brown. Seeds about 85 % dry matter	99	Harvested product

1.3.7 Phenological growth stages and BBCH-identification keys of beet (*Beta vulgaris* L. ssp. *vulgaris*), Meier et al., 1993

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development (youth stage)**	
00	Dry seed	10	First leaf visible (pinhead-size): cotyledons horizontally unfolded
01	Beginning of imbibition: seeds begins to take up water	11	First pair of leaves visible, not yet unfolded (pea-size)
02	-	12	2 leaves (first pair of leaves) unfolded
03	Seed imbibition complete (pellet cracked)	13	-
04	-	14	4 leaves (2nd pair of leaves) unfolded
05	Radicle emerged from seed (pellet)	15	5 leaves unfolded
06	-	1 .	Stages continuous till ...
07	Shoot emerged from seed (pellet)	19	9 and more leaves unfolded
08	-		
09	Emergence: shoot emerges through soil surface		

Beet

Code	Description	Code	Description
Principal growth stage 2: ———		**Principal growth stage 4:**	**Development of harvestable vegetative plant parts - Beet root**
Principal growth stage 3: Rosette growth (crop cover)			
30	-	40	-
31	Beginning of crop cover: leaves cover 10 % of ground	41	-
32	Leaves cover 20 % of ground	42	-
33	Leaves cover 30 % of ground	43	-
34	Leaves cover 40 % of ground	44	-
35	Leaves cover 50 % of ground	45	-
36	Leaves cover 60 % of ground	46	-
37	Leaves cover 70 % of ground	47	-
38	Leaves cover 80 % of ground	48	-
39	Crop cover complete: leaves cover 90 % of ground	49	Beet root has reached harvestable size

Beet

Code	Description	Code	Description
Principal growth stage 5: Inflorescence emergence (2nd year of growth)		**Principal growth stage 6: Flowering**	
50	-	60	First flowers open
51	Beginning of elongation of main stem	61	Beginning of flowering: 10 % of flowers open
52	Main stem 20 cm long	62	20 % of flowers open
53	Side shoot buds visible on main stem	63	30 % of flowers open
54	Side shoots clearly visible on main stem	64	40 % of flowers open
55	First individual flower buds on side shoots visible	65	Full flowering: 50 % of flowers open
56	-	66	-
57	-	67	Flowering declining: 70 % of flowers open or dry
58	-	68	-
59	First bracts visible; flower buds still closed	69	End of flowering: all flowers dry, fruit set visible

Code	Description	Code	Description
Principal growth stage 7: Development of fruit		**Principal growth stage 8: Ripening**	
70	-	80	-
71	Beginning of seed development: seeds visible in infructescence	81	Beginning of ripening: pericarp green-brown, seed coat light brown
72	-	82	-
73	-	83	-
74	-	84	-
75	Pericarp green; fruit still mouldable; perisperm milky; colour of seed coat: beige	85	Pericarp light brown, seed coat reddish brown
76	-	86	-
77	-	87	Pericarp hard, seed coat dark brown
78	-	88	-
79	-	89	Fully ripe: seed coat final colour (specific to variety and species), perisperm hard

Beet

Code	Description
Principal growth stage 9: Senescence	
90	-
91	Beginning of leaf discolouration
92	-
93	Most leaves yellowish
94	-
95	50 % of leaves brownish
96	-
97	Leaves dead
98	-
99	Harvested product (seeds)

1.3.8 Phenological growth stages and BBCH-identification keys of potato (*Solanum tuberosum* L.), Hack et al., 1993

Code		Description of development from tuber	Description of development from seed
2- and 3digit			
Principal growth stage 0: Sprouting/Germination			
00	000	Innate or enforced dormancy, tuber not sprouted	Dry seed
01	001	Beginning of sprouting: sprouts visible (< 1 mm)	Beginning of seed imbibition
02	002	Sprouts upright (< 2 mm)	-
03	003	End of dormancy: sprouts 2 - 3 mm	Seed imbibition complete
04	004	-	-
05	005	Beginning of root formation	Radicle (root) emerged from seed
06	006	-	-
07	007	Beginning of stem formation	Hypocotyl with cotyledons breaking
08	008	Stems growing towards soil surface, formation of scale leaves in the axils of which stolons will develop later	Hypocotyl with cotyledons growing towards soil surface
09	009	Emergence: stems break through soil surface	Emergence: cotyledons break through soil surface
	021 - 029 [1]		

[1] *For second generation sprouts*

Code		Description of development from tuber and seed	Code	Description of development from tuber and seed
2- and 3digit			2- and 3digit	
Principal growth stage 1: Leaf development				
10	100	From tuber: first leaves begin to extend From seed: cotyledons completely unfolded	- 121	First leaf of 2nd order branch above first inflorescence unfolded (> 4 cm)
11	101	1st leaf of main stem unfolded (> 4 cm)	- 122	2nd leaf of 2nd order branch above first inflorescence unfolded (> 4 cm)
12	102	2nd leaf of main stem unfolded (> 4 cm)	- 12 .	Stages continuous till ...
13	103	3rd leaf Auf main stem unfolded (> 4 cm)	- 131	First leaf of 3rd order branch above 2nd inflorescence unfolded (> 4 cm)
1 .	10 .	Stages continuous till ...	- 132	2nd leaf of 3rd order branch above 2nd inflorescence unfolded (> 4 cm)
19	109	9 or more leaves of main stem unfolded (> 4cm) (2digit);[2] 9 leaves of main stem unfolded (> 4 cm) (3digit)	- 13 .	Stages continuous till ...
-	110	10th leaf of main stem unfolded (> 4 cm)	- 1NX	Xth leaf of nth order branch above n-1th inflorescence unfolded (> 4 cm)
-	11 .	Stages continuous till ...		
-	119	19. leaf of main stem unfolded (> 4 cm)		

[2] *Stem development stops after termination of main stem by an inflorescence. Branches arise from axils of upper leaves of the main stem, exhibiting a sympodial branching pattern*

Potato

Codes		Description
2- and 3digit		
Principal growth stage 2:		**Formation of basal side shoots - below and above soil surface (main stem)**
20	200	-
21	201	First basal side shoot visible (> 5 cm)
22	202	2nd basal side shoot visible (> 5 cm)
23	203	3rd basal side shoot visible (> 5 cm)
2 .	20 .	Stages continuous till ...
29	209	9 or more basal side shoots visible (> 5 cm)

Codes		Description
2- and 3digit		
Principal growth stage 3: Main stem elongation (crop cover)		
30	300	-
31	301	Beginning of crop cover: 10 % of plants meet between rows
32	302	20 % off plants meet between rows
33	303	30 % of plants meet between rows
34	304	40 % of plants meet between rows
35	305	50 % of plants meet between rows
36	306	60 % of plants meet between rows
37	307	70 % of plants meet between rows
38	308	80 % of plants meet between rows
39	309	Crop cover complete: about 90 % of plants meet between rows

Codes		Description	Codes		Description
2- and 3digit		**Principal growth stage 4: Tuber formation**	2- and 3digit		**Principal growth stage 5: Inflorescence (cyme) emergence**
40	400	Tuber initiation: swelling of first stolon tips to twice the diameter of subtending stolon	50	500	-
41	401	10 % of total final tuber mass reached	51	501	First individual buds (1 - 2 mm) of first inflorescence visible (main stem)
42	402	20 % of total final tuber mass reached	52	502	-
43	403	30 % of total final tuber mass reached	53	503	-
44	404	40 % of total final tuber mass reached	54	504	-
45	405	50 % of total final tuber mass reached	55	505	Buds of first inflorescence extended to 5 mm
46	406	60 % of total final tuber mass reached	56	506	-
47	407	70 % of total final tuber mass reached	57	507	-
48	408	Maximum of total tuber mass reached, tubers detach easily from stolons, skin set not yet complete (skin easily removable with thumb)	58	508	-
49	409	Skin set complete: (skin at apical end of tuber not removable with thumb) 95 % of tubers in this stage	59	509	First flower petals of first inflorescence visible

Codes 2- and 3digit	Description
Principal growth stage 5: Inflorescence emergence (continuation)	
521	Individual buds of 2nd inflorescence visible (second order branch)
525	Buds of 2nd inflorescence extended to 5 mm open (main stem)
529	First flower petals of 2nd inflorescence visible above sepals
531	Individuell buds of 3rd inflorescence visible(3rd order branch)
535	Buds of 3rd inflorescence extended to 5 mm
539	First flower petals of 3rd inflorescence visible above sepals
5N .	Nth inflorescence emerging

Codes 2- and 3digit		Description
Principal growth stage 6: Flowering		
60	600	First open flowers in population
61	601	Beginning of flowering: 10 % of flowers in the first inflorescence open (main stem)
62	602	20 % of flowers in the first inflorescence open
63	603	30 % of flowers in the first inflorescence open
64	604	40 % of flowers in the first inflorescence open
65	605	Full flowering: 50 % of flowers in the first inflorescence open
66	606	60 % of flowers in the first inflorescence open
67	607	70 % of flowers in the first inflorescence open
68	608	80 % of flowers in the first inflorescence open
69	609	End of flowering in the first inflorescence

Codes		Description
2- and 3digit		**Principal growth stage 6: Flowering (continuation)**
-	621	Beginning of flowering: 10 % of flowers in the 2nd inflorescence open (second order branch)
-	625	Full flowering: 50 % of flowers in the 2nd inflorescence open
-	629	End of flowering in the 2nd inflorescence
-	631	Beginning of flowering: 10 % of flowers in the 3rd inflorescence open (third order branch)
-	635	Full flowering: 50 % of flowers in the 3rd inflorescence open
-	639	End of flowering in the 3rd inflorescence
-	6N .	Nth inflorescence flowering
-	6N9	End of flowering

Codes		Description
2- and 3digit		**Principal growth stage 7: Development of fruit**
70	700	First berries visible
71	701	10 % of berries in the first fructification have reached full size (main stem)
72	702	20 % of berries in the first fructification have reached full size
73	703	30 % of berries in the first fructification have reached full size
7 .	70 .	Stages continuous till ...
-	721	10 % of berries in the 2nd fructification have reached full size (second order branch)
-	7N .	Development of berries in nth fructification
-	7N9	Nearly all berries in the nth fructification have reached full size (or have been shed)

Codes 2- and 3digit		Description	Codes 2- and 3digit		Description
Principal growth stage 8: Ripening of fruit and seed			**Principal growth stage 9: Senescence**		
80	800	-	90	900	-
81	801	Berries in the first fructification still green, seed light-coloured (main stem)	91	901	Beginning of leaf yellowing
82	802	-	92	902	-
83	803	-	93	903	Most of the leaves yellowish
84	804	-	94	904	-
85	805	Berries in the first fructification ochre-coloured or brownish	95	905	50 % of the leaves brownish
86	806	-	96	906	-
87	807	-	97	907	Leaves and stem dead, stems bleached and dry
88	808	-	98	908	-
89	809	Berries in the first fructification shrivelled, seed dark	99	909	Harvested product
-	821	Berries in the 2nd fructification still green, seed light-coloured (second order branch)			
-	8N .	Ripening of fruit and seed in nth fructification			

1.3.9 Phenological growth stages and BBCH-identification keys of the soybean (*Glycine max* L. Merr.)

Code		Description
2- and 3digit		
Principal growth stage 0: Germination		
00	000	Dry seed
01	001	Beginning of seed imbibition
02	002	-
03	003	Seed imbibition complete
04	004	-
05	005	Radicle emerged from seed
06	006	Elongation of radicle; formation of root hairs
07	007	Hypocotyl with cotyledons breaking through seed coat
08	008	Hypocotyl reaches the soil surface; hypocotyl arch visible
09	009	Emergence: hypocotyl with cotyledons emerged above soil surface („cracking stage")

Code		Description
2- and 3digit		
Principal growth stage 1: Leaf development (Main shoot)		
10	100	Cotyledons completely unfolded
11	101	First pair of true leaves unfolded (unifoliolate leaves on the first node)
12	102	Trifoliolate leaf on the 2nd node unfolded
13	103	Trifoliolate leaf on the 3rd node unfolded
1 .	10 .	Stages continuous till ...
19	109	Trifoliolate leaf on the 9th node unfolded. No side shoots visible [1]
-	110	Trifoliolate leaf on the 10th node unfolded [1]
-	111	Trifoliolate leaf on the 11th node unfolded [1]
-	112	Trifoliolate leaf on the 12th node unfolded [1]
-	113	Trifoliolate leaf on the 13th node unfolded [1]
-	11 .	Stages continuous till ...
-	119	Trifoliolate leaf on the 19th node unfolded [1]

[1] *The side shoot development may occur earlier; in this case continue with the principal growth stage 2*

Soybean

Code		Description
2- and 3digit		
Principal growth stage 2: Formation of side shoots		
20	200	-
21	201	First side shoot visible
22	202	2nd side shoot of first order visible
23	203	3rd side shoot of first order visible
2 .	20 .	Stages continuous till ...
29	209	9 or more side shoots of first order visible (2 digit) 9th side shoot of first order visible (3 digit)
-	210	10th side shoot of first order visible
-	221	First side shoot of 2nd order visible
-	22 .	Stages continuous till ...
-	229	9th side shoot of 2nd order visible
-	2N1	First side shoot of Nth order visible
-	2N9	9th side shoot of Nth order visible

Code		Description
2- and 3digit		
Principal growth stage 3: ——— [2]		
Principal growth stage 4: Development of harvestable vegetative plant parts -Main shoot-		
40	400	-
41	401	-
42	402	-
43	403	-
44	404	-
45	405	-
46	406	-
47	407	-
48	408	-
49	409	Harvestable vegetative plant parts have reached final size (Cutting of soybean plants for feeding purposes)

[2] *The stem elongation of the soybean plant (Principal growth stage 3) proceeds parallel to leaf development. Thereforce a coding in principal growth stage 3 is omitted*

Code		Description	Code		Description
2- and 3digit			2- and 3digit		
Principal growth stage 5: Inflorescence emergence (Main shoot)			**Principal growth stage 6: Flowering (Main shoot)**		
50	500	-	60	600	First flowers opened (sporadically in population)
51	501	First flower buds visible	61	601	Beginning of flowering: about 10 % of flowers open [3] Beginning of flowering [4]
52	502	-	62	602	About 20 % of flowers open [3]
53	503	-	63	603	About 30 % of flowers open [3]
54	504	-	64	604	About 40 % of flowers open [3]
55	505	First flower buds enlarged	65	605	Full flowering: about 50 % of flowers open [3] Main period of flowering [4]
56	506	-	66	606	About 60 % of flowers open [3]
57	507	-	67	607	Flowering declining [3]
58	508	-	68	608	-
59	509	First flower petals visible; flower buds still closed	69	609	End of flowering: first pods visible (approx. 5 mm length) [3]

[3] *This definition refers to determinate varieties*
[4] *This definition refers to indeterminate varieties*

Soybean

Code		Description
2- and 3digit		**Principal growth stage 7: Development of fruits and seeds**
70	700	First pod reached final length (15 - 20 mm)
71	701	About 10 % of pods have reached final length (15 - 20 mm) [3] Beginning of pod development [4]
72	702	About 20 % of pods have reached final length (15 - 20 mm) [3]
73	703	About 30 % of pods have reached final length (15 - 20 mm) [3] Beginning of pod filling [4]
74	704	About 40 % of pods have reached final length (15 - 20 mm) [3]
75	705	About 50 % of pods have reached final length (15 - 20 mm). Continuation of pod filling.[3] Main period of pod development. Continuation of pod filling [4]
76	706	-
77	707	About 70 % of pods have reached final length (15 - 20 mm); Advanced pod filling.[3] Advanced pod filling [4]
78	708	-
79	709	Approx. all pods have reached final length (15 - 20 mm). Seeds filling the cavity of the majority of pods [3, 4]

Code		Description
2- and 3digit		**Principal growth stage 8: Ripening of fruits and seeds**
80	800	First pod ripe, beans final colour, dry and hard
81	801	Beginning of ripening; about 10 % of pods are ripe, beans final colour, dry and hard.[3] Beginning of pod and seed ripening [4]
82	802	About 20 % of pods are ripe; beans final colour, dry and hard [3]
83	803	About 30 % of pods are ripe; beans final colour, dry and hard [3]
84	804	About 40 % of pods are ripe; beans final colour, dry and hard [3]
85	805	Advanced ripening; about 50 % of pods are ripe ; beans final colour, dry and hard. [3] Main period of pod and seed ripening [4]
86	806	About 60 % of pods are ripe; beans final colour, dry and hard [3]
87	807	About 70 % of pods are ripe; beans final colour, dry and hard [3]
88	808	About 80 % of pods are ripe; beans final colour, dry and hard [3]
89	809	Full maturity: approx. all pods are ripe; beans final colour, dry and hard (= Harvest maturity).[3] Majority of pods are ripe; beans final colour, dry and hard [4]

[3] *This definition refers to determinate varieties*

[4] *This definition refers to indeterminate varieties*

Soybean

Code		Description
2- and 3digit		
Principal growth stage 9: Senescence		
90	900	
91	901	About 10 % of leaves discoloured or fallen
92	902	About 20 % of leaves discoloured or fallen
93	903	About 30 % of leaves discoloured or fallen
94	904	About 40 % of leaves discoloured or fallen
95	905	About 50 % of leaves discoloured or fallen
96	906	About 60 % of leaves discoloured or fallen
97	907	Above ground parts of plants dead
98	908	
99	909	Harvested product (seeds)

1.3.10 Phenological growth stages and BBCH-identification keys of the cotton (*Gossypium hirsutum* L.)

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development (Main shoot)**	
00	Dry seed	10	Cotyledons completely unfolded [1]
01	Beginning of seed imbibition	11	First true leaf unfolded [1]
02	-	12	2nd true leaf unfolded [1]
03	Seed imbibition complete	13	3rd true leaf unfolded [1]
04	-	1 .	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more true leaves unfolded;[1] no side shoots visible [2]
06	Elongation of radicle		
07	Hypocotyl with cotyledons breaking through seed coat		
08	Hypocotyl with cotyledons growing towards soil surface		
09	Emergence: hypocotyl with cotyledons breaking through soil surface („crook stage“)		

[1] *Leaves are counted from the cotyledon node (= node 0)*

[2] *Side shoot development may occur earlier; if there is a vegetative side shoot continue with principal growth stage 2. If there is a reproductive side shoot (fruiting branch) continue with the principal growth stage 5*

Cotton

Code	Description
Principal growth stage 2: Formation of side shoots [3]	
20	-
21	First vegetative side shoot (2nd order) visible
22	2 vegetative side shoots (2nd order) visible
23	3 vegetative side shoots (2nd order) visible
2 .	Stages continuous till ...
29	9 or more vegetative side shoots (2nd order) visible

Code	Description
Principal growth stage 3: Main stem elongation (Crop cover)	
30	-
31	Beginning of crop cover: 10 % of plants meet between rows
32	20 % of plants meet between rows
33	30 % of plants meet between rows
34	40 % of plants meet between rows
35	50 % of plants meet between rows
36	60 % of plants meet between rows
37	70 % of plants meet between rows
38	80 % of plants meet between rows
39	Canopy closure: 90 % of the plants meet between rows

[3] *Vegetative side shoots are counted from the cotyledon node*

Cotton

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence (Main shoot)	
50	-
51	First floral buds detectable („pin-head square“) [4]
52	First floral buds visible („match-head square“) [4]
53	-
54	-
55	Floral buds distinctly enlarged
56	-
57	-
58	-
59	Petals visible: floral buds still closed
Principal growth stage 6: Flowering	
60	First flowers opened (sporadically within the population)
61	Beginning of flowering ("Early bloom“): 5 - 6 blooms / 25 ft of row (= 5 -6 blooms / 7,5 meter of row)
62	-
63	-
64	-
65	Full flowering: ("Mid bloom“): 11 and more blooms / 25 ft of row = 11 and more blooms / 7,5 meter of row
66	-
67	Flowering finishing: majority of flowers faded ("Late bloom“)
68	-
69	End of flowering

[4] *„pin-head square“ or „match-head square“ is the first square which forms at the first fruiting position of the first fruiting branch*

Code	Description	Code	Description
Principal growth stage 7: Development of fruits and seeds		**Principal growth stage 8: Ripening of fruits and seeds**	
70		80	Firstst open bolls on the first fruiting branches
71	About 10 % of bolls have attained their final size	81	Beginning of boll opening: about 10 % of bolls open. Nodes Above White Flower (NAWF)
72	About 20 % of bolls have attained their final size	82	About 20 % of bolls open
73	About 30 % of bolls have attained their final size	83	About 30 % of bolls open. Nodes Above Cracked Boll (NACB)
74	About 40 % of bolls have attained their final size	84	About 40 % of bolls open
75	About 50 % of bolls have attained their final size	85	About 50 % of bolls open
76	About 60 % of bolls have attained their final size	86	About 60 % of bolls open
77	About 70 % of bolls have attained their final size	87	About 70 % of bolls open
78	About 80 % of bolls have attained their final size	88	About 80 % of bolls open
79	About 90 % of bolls have attained their final size	89	About 90 % of bolls open

Cotton

Code	Description
Principal growth stage 9: Senescence	
90	-
91	About 10 % of leaves discoloured or fallen
92	About 20 % of leaves discoloured or fallen
93	About 30 % of leaves discoloured or fallen
94	About 40 % of leaves discoloured or fallen
95	About 50 % of leaves discoloured or fallen
96	About 60 % of leaves discoloured or fallen
97	Above ground parts of plant dead; plant dormant
98	-
99	Harvested product (bolls and seeds)

1.3.11 Phenological growth stages and BBCH-identification keys of the peanut (*Arachis hypogaea* L.)

Code	Description
Principal growth stage 0: Germination	
00	Dry seed
01	Beginning of seed imbibition
02	-
03	Seed imbibition complete
04	-
05	Radicle emerged from seed
06	-
07	Hypocotyl with cotyledons breaking through seed coat
08	Hypocotyl reaches the soil surface; hypocotyl arch visible
09	Emergence: hypocotyl with cotyledons arising above soil surface („cracking stage")

Code	Description
Principal growth stage 1: Leaf development (Main shoot)	
10	Cotyledons completely unfolded [1]
11	First true leaf (pinnate) unfolded [1]
12	2nd true leaf (pinnate) unfolded [1]
13	3rd true leaf (pinnate) unfolded [1]
1.	Stages continuous till ...
19	9 or more true leaves unfolded.[1] No side shoots visible [2]

[1] *Leaves are counted from the cotyledon node (= node 0)*

[2] *Side shoot development may occur earlier; in this case continue with principal growth stage 2*

Peanut

Code	Description
Principal growth stage 2: Formation of side shoots [3]	
20	
21	1st side shoot visible
22	2nd side shoot visible
23	3rd side shoot visible
2 .	Stages continuous till ...
29	9 or more side shoots visible

Code	Description
Principal growth stage 3: Main stem elongation (Crop cover)	
30	
31	Beginning of crop cover: 10 % of plants meets between rows
32	20 % of plants meets between rows
33	30 % of plants meets between rows
34	40 % of plants meets between rows
35	50 % of plants meets between rows
36	60 % of plants meets between rows
37	70 % of plants meets between rows
38	80 % of plants meets between rows
39	Crop cover complete: 90 % of plants meets between rows

[3] *Side shoots are counted from the cotyledon node (= node 0)*

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	First inflorescence buds visible
52	-
53	-
54	-
55	First individual flower buds visible
56	-
57	-
58	-
59	First flower petals visible. Flower buds still closed

Code	Description
Principal growth stage 6: Flowering	
60	-
61	Beginning of flowering
62	First carpophore pegs visible
63	Continuation of flowering
64	First carpophore pegs visibly elongated
65	Full flowering
66	First carpophore pegs penetrating the soil
67	Flowering declining [4]
68	Tip of first carpophore pegs growing horizontally in the soil
69	End of flowering [4]

[4] *Only for varieties with a determinate flowering period*

Peanut

Code	Description	Code	Description
Principal growth stage 7: Development of fruits and seeds		**Principal growth stage 8: Ripening of fruits and seeds** [5]	
70	-	80	-
71	Beginning of pod development: tip of first carpophore pegs swollen (at least twice the original diameter)	81	Beginning of ripening: about 10 % of pods developed to final size are ripe
72	-	82	About 20 % of pods developed to final size are ripe
73	Continuation of pod development: beginning of pod filling: first pods have attained final size and are ripening	83	Continuation of ripening: about 30 % of pods developed to final size are ripe
74	-	84	About 40 % of pods developed to final size are ripe
75	Main phase of pod development: continuation of pod filling	85	Main phase of ripening: about 50 % of pods developed to final size are ripe
76	-	86	About 60 % of pods developed to final size are ripe
77	Advanced pod filling	87	Advanced ripening: about 70 % of pods developed to final size are ripe
78	-	88	About 80 % of pods developed to final size are ripe
79	Fresh seeds fill the cavity of the pods which have attained their final size	89	Full maturity: nearly all pods developed to final size are ripe

[5] *Criteria of maturity: Pericarp hard, with distinct texture, can be split open easily; Testa (seed coat) dry, with cultivar-specific dark colour*

Peanut

Code	Description
Principal growth stage 9: Senescence	
90	-
91	About 10 % of above ground parts of plant dry
92	About 40 % of above ground parts of plant dry
93	About 30 % of above ground parts of plant dry
94	About 40 % of above ground parts of plant dry
95	About 50 % of above ground parts of plant dry
96	About 60 % of above ground parts of plant dry
97	Above ground parts of plant dead
98	-
99	Harvested product

1.3.12 Phenological growth stages and identification keys of pome fruit (apple = *Malus domestica* Borkh., pear = *Pyrus communis* L.), Meier et al., 1994

Code	Description	Code	Description
Principal growth stage 0: Sprouting/Bud development		**Principal growth stage 1: Leaf development**	
00	Dormancy: leaf buds and the thicker inflorescence buds closed and covered by dark brown scales	10	Green leaf tips 10 mm above the bud scales; first leaves separating
01	Beginning of leaf bud swelling: buds visibly swollen, bud scales elongated, with light coloured patches	11	First leaves unfolded (others still unfolding)
02	-	12	-
03	End of leaf bud swelling: bud scales light coloured with some parts densely covered by hairs	13	-
04	-	14	-
05	-	15	More leaves unfolded, not yet at full size
06	-	16	-
07	Beginning of bud break: first green leaf tips just visible	17	-
08	-	18	-
09	Green leaf tips about 5 mm above bud scales	19	First leaves fully expanded

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Shoot development [1]	
30	-
31	Beginning of shoot growth: axes of developing shoots visible
32	Shoots about 20 % of final length
33	Shoots about 30 % of final length
3 .	Stages continuous till ...
39	Shoots about 90 % of final length

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	Inflorescence buds swelling: bud scales elongated, with light coloured patches
52	End of bud swelling: light coloured bud scales visible with parts densely covered by hairs
53	Bud burst: green leaf tips enclosing flowers visible
54	Mouse-ear stage: green leaf tips 10 mm above bud scales; first leaves separating
55	Flower buds visible (still closed)
56	Green bud stage: single flowers separating (still closed)
57	Pink bud stage: flower petals elongating; sepals slightly open; petals just visible
58	-
59	Most flowers with petals forming a hollow ball

[1] *From terminal bud*

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open	70	-
61	Beginning of flowering: about 10 % of flowers open	71	Fruit size up to 10 mm; fruit fall after flowering
62	About 20 % of flowers open	72	Fruit size up to 20 mm
63	About 30 % of flowers open	73	Second fruit fall
64	About 40 % of flowers open	74	Fruit diameter up to 40 mm; fruit erect (T-stage: underside of fruit and stalk forming a T)
65	Full flowering: at least 50 % of flowers open, first petals falling	75	Fruit about half final size
66	-	76	Fruit about 60 % final size
67	Flowers fading: majority of petals fallen	77	Fruit about 70 % final size
68	-	78	Fruit about 80 % final size
69	End of flowering: all petals fallen	79	Fruit about 90 % final size

Code	Description	Code	Description
Principal growth stage 8: Maturity of fruit and seed		**Principal growth stage 9: Senescence, beginning of dormancy**	
80	-	90	-
81	Beginning of ripening: first appearance of cultivar-specific colour	91	Shoot growth completed; terminal bud developed; foliage still fully green
82	-	92	Leaves begin to discolour
83	-	93	Beginning of leaf fall
84	-	94	-
85	Advanced ripening: increase in intensity of cultivar-specific colour	95	50 % of leaves discoloured
86	-	96	-
87	Fruit ripe for picking	97	All leaves fallen
88	-	98	-
89	Fruit ripe for consumption: fruit have typical taste and firmness	99	Harvested product

1.3.13 Phenological growth stages and BBCH-identification keys of stone fruit (cherry = *Prunus cerasus* L., plum = *Prunus domestica* L. ssp. *domestica*, peach = *Prunus persica* Batsch., apricot = *Prunus ameriaca* L.), Meier et al., 1994

Code	Description	Code	Description
Principal growth stage 0: Sprouting/Bud development		**Principal growth stage 1: Leaf development**	
00	Dormancy: leaf buds and the thicker inflorescence buds closed and covered by dark brown scales	10	First leaves separating: green scales slightly open, leaves emerging
01	Beginning of bud swelling (leaf buds); light brown scales visible, scales with light coloured edges	11	First leaves unfolded, axis of developing shoot visible
02	-	12	-
03	End of leaf bud swelling: scales separated, light green bud sections visible	13	-
04	-	14	-
05	-	15	-
06	-	16	-
07	-	17	-
08	-	18	-
09	Green leaf tips visible: brown scales fallen, buds enclosed by light green scales	19	First leaves fully expanded

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Shoot development [1]	
30	-
31	Beginning of shoot growth: axes of developing shoots visible
32	Shoots about 20 % of final length
33	Shoots about 30 % of final length
3 .	Stages continuous till ...
39	Shoots about 90 % of final length

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	Inflorescence buds swelling: buds closed, light brown scales visible
52	-
53	Bud burst: scales separated, light green bud sections visible
54	Inflorescence enclosed by light green scales, if such scales are formed (not all cultivars)
55	Single flower buds visible (still closed) borne on short stalks, green scales slightly open
56	Flower pedicel elongating; sepals closed; single flowers separating
57	Sepals open: petal tips visible; single flowers with white or pink petals (still closed)
58	-
59	Most flowers with petals forming a hollow ball

[1] *From terminal bud*

Stone fruit

Code	Description	Code	Description
Principal growth stage 6: Flowering		***Principal growth stage 7: Development of fruit***	
60	First flowers open	70	-
61	Beginning of flowering: about 10 % of flowers open	71	Ovary growing; fruit fall after flowering
62	About 20 % of flowers open	72	Green ovary surrounded by dying sepal crown, sepals beginning to fall
63	About 30 % of flowers open	73	Second fruit fall
64	About 40 % of flowers open	74	-
65	Full flowering: at least 50 % of flowers open, first petals falling	75	Fruit about half final size
66	-	76	Fruit about 60 % of final size
67	Flowers fading: majority of petals fallen	77	Fruit about 70 % of final size
68	-	78	Fruit about 80 % of final size
69	End of flowering: all petals fallen	79	Fruit about 90 % of final size

Stone fruit

Code	Description	Code	Description
Principal growth stage 8: Maturity of fruit and seed		**Principal growth stage 9: Senescence, beginning of dormancy**	
80	-	90	-
81	Beginning of fruit colouring	91	Shoot growth completed; foliage still fully green
82	-	92	Leaves begin to discolour
83	-	93	Beginning of leaf fall
84	-	94	-
85	Colouring advanced	95	50 % of leaves discoloured or fallen
86	-	96	-
87	Fruit ripe for picking	97	All leaves fallen
88	-	98	-
89	Fruit ripe for consumption: fruit have typical taste and firmness	99	Harvested product

1.3.14 Phenological growth stages and BBCH-identification keys of citrus (*Citrus* spp. L.), Agusti et al., 1995

Code	Description	Code	Description
Principal growth stage 0: Sprouting/Bud development		**Principal growth stage 1: Leaf development**	
00	Dormancy: leaf and inflorescence buds undifferentiated, closed and covered by green scales	10	First leaves separating: green scales slightly open, leaves emerging
01	Beginning of bud swelling	11	First leaves visible [1]
02	-	12	-
03	End of bud swelling: green scales slightly separated	13	-
04	-	14	-
05	-	15	More leaves visible, not yet at full size
06	-	16	-
07	Beginning of bud burst	17	-
08	-	18	-
09	Green leaf tips visible	19	First leaves fully expanded

[1] *In Citrus the term „visible" replaces „unfolded" used for other fruit species. Leaf unfolding takes place precociously in citrus*

Code	Description	Code	Description
Principal growth stage 2:		**Principal growth stage 4:**	
Principal growth stage 3: Shoot development		**Principal growth stage 5: Inflorescence emergence**	
30	-	50	-
31	Beginning of shoot growth: axes of developing shoots visible	51	Inflorescence buds swelling: buds closed, light green scales visible
32	Shoots about 20 % of final length	52	-
33	-	53	Bud burst: scales separated, floral tips visible
34	-	54	-
35	-	55	Flowers visible, still closed (green bud), borne on single or multiflowered leafy or leafless inflorescences
36	-	56	Flower petals elongating; sepals covering half corolla (white bud)
37	-	57	Sepals open: petal tips visible; flowers with white or purplish petals, still closed
38	-	58	-
39	Shoots about 90 % of final length	59	Most flowers with petals forming a hollow ball

Citrus

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open	70	-
61	Beginning of flowering: about 10 % of flowers open	71	Fruit set; beginning of ovary growth; beginning of fruitlets abscission
62	-	72	Green fruit surrounded by sepal crown
63	-	73	Some fruits slightly yellow: beginning of physiological fruit drop
64	-	74	Fruits about 40 % of final size. Dark green fruit: end of physiological fruit drop
65	Full flowering: 50 % of flowers open; first petals falling	75	-
66	-	76	-
67	Flowers fading: majority of petals fallen	77	-
68	-	78	-
69	End of flowering: all petals fallen	79	Fruits about 90 % of final size

Citrus

Code	Description	Code	Description
Principal growth stage 8: Maturity of fruit		**Principal growth stage 9: Senescence, beginning of dormancy**	
80	-	90	-
81	Beginning of fruit colouring (colour-break)	91	Shoot growth complete; foliage fully green
82	-	92	-
83	Fruit ripe for picking; fruit has not yet developed variety-specific colour	93	Beginning of senescense and abscission of old leaves
84	-	94	-
85	Advanced ripening; increase in intensity of variety-specific colour	95	-
86	-	96	-
87	-	97	Winter dormancy period
88	-	98	-
89	Fruit ripe for consumption; fruit has typical taste and firmness; beginning of senescence and fruit abscission	99	-

1.3.15 Phenological growth stages and BBCH-identification keys of currants (black currant = *Ribes nigrum* L., red currant = *Ribes rubrum* L.), Meier et al., 1994

Code	Description	Code	Description
Principal growth stage 0: Sprouting/Bud development		**Principal growth stage 1: Leaf development**	
00	Dormancy: leaf buds and the thicker inflorescence buds closed and covered by dark brown scales	10	Leaf tips above the bud scales: first leaves separating
01	Beginning of bud swelling: bud scales elongated	11	First leaves unfolded (others still unfolding)
02	-	12	-
03	End of bud swelling: edges of bud scales light coloured	13	-
04	-	14	-
05	-	15	More leaves unfolded, not yet full size
06	-	16	-
07	Beginning of bud burst: first green or red leaf tips just visible	17	-
08	-	18	-
09	Leaf tips extended beyond scales	19	First leaves fully expanded

Currants

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Shoot development [1]	
30	-
31	Beginning of shoot growth: axes of developing shoots visible
32	Shoots about 20 % of final length
33	Shoots about 30 % of final length
3.	Stages continuous till ...
39	Shoots about 90 % of final length

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	Inflorescence buds and leaf buds swelling: buds closed, light brown scales visible
52	-
53	Bud burst: scales separated light green but sections visible
54	Green or red leaf tips above bud scales
55	First flower buds (compact raceme) visible beside unfolded leaves
56	Beginning of raceme elongation
57	First flower bud separated on elongating raceme
58	-
59	Grape stage: all flower buds separated

[1] *From terminal bud*

Currants

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open	70	-
61	Beginning of flowering: about 10 % of flowers open	71	Beginning of fruit growth: first fruits visible at raceme base
62	-	72	20 % of fruits formed
63	-	73	30 % of fruits formed
64	-	74	40 % of fruits formed
65	Full flowering: at least 50 % of flowers open, first petals falling	75	50 % of fruits formed
66	-	76	60 % of fruits formed
67	Flowers fading: majority of petals fallen	77	70 % of fruits formed
68	-	78	80 % of fruits formed
69	End of flowering: all petals fallen	79	90 % of fruits formed

Currants

Code	Description	Code	Description
Principal growth stage 8: Maturity of fruit and seed		**Principal growth stage 9: Senescence, beginning of dormancy**	
80	-	90	-
81	Beginning of ripening: change to cultivar-specific fruit color	91	Shoot growth completed; terminal bud developed; foliage still fully green
82	-	92	Leaves begin to discolour
83	-	93	Beginning of leaf fall
84	-	94	-
85	Advanced ripening: first berries at base of racemes have cultivar-specific color	95	50 % of leaves discoloured or fallen
86	-	96	-
87	Fruit ripe for picking: most berries ripe	97	All leaves fallen
88	-	98	-
89	Berries at base of racemes tending to drop (beginning of fruit abscission)	99	Harvested product

1.3.16 Phenological growth stages and BBCH-identification keys of strawberry (*Fragaria ananassa* Duch.), Meier et al., 1994

Code	Description	Code	Description
Principal growth stage 0: Sprouting/Bud development		**Principal growth stage 1: Leaf development**	
00	Dormancy: Leaves prostrate and partly dead	10	First leaf emerging
01	-	11	First leaf unfolded
02	-	12	2nd leaf unfolded
03	Main bud swelling	13	3rd leaf unfolded [1]
04	-	1.	Stages continuous till ...
05	-	19	9 or more leaves unfolded
06	-		
07	-		
08	-		
09	-		

[1] *Normally after the three leaf stage the bud development occurs in principal growth stage 5*

Strawberry

Code	Description
Principal growth stage 2:	
Principal growth stage 3:	
Principal growth stage 4: Development of stolons and young plants	
40	-
41	Beginning of stolon (runner) formation: stolons visible (about 2 cm long)
42	First daughter plant visible
43	Beginning of root development in first daughter plant
44	-
45	First daughter plant with roots (ready for planting)
46	-
47	-
48	-
49	Several daughter plants with roots (ready for planting)
Principal growth stage 5: Inflorescence emergence	
50	-
51	-
52	-
53	-
54	-
55	First set flowers at the bottom of the rosette
56	Inflorescence elongating
57	First flower buds emerged (still closed)
58	Early balloon stage: first flowers with petals forming a hollow ball
59	Most flowers with petals forming a hollow ball

Strawberry

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open (primary or A-flower)	70	-
61	Beginning of flowering: about 10 % of flowers open	71	Receptacle protruding from sepal whorl
62	-	72	-
63	-	73	Seeds clearly visible on receptacle tissue
64	-	74	-
65	Full flowering: secondary (B) and tertiary (C) flowers open, first petals falling	75	-
66	-	76	-
67	Flowers fading: majority of petals fallen	77	-
68	-	78	-
69	-	79	-

Code	Description	Code	Description
Principal growth stage 8: Maturity of fruit		**Principal growth stage 9: Senescence, beginning of dormancy**	
80	-	90	-
81	Beginning of ripening: most fruits white in colour	91	Beginning of axillary bud formation
82	-	92	New leaves with smaller lamina and shortened stalk visible
83	-	93	Old leaves dying, young leaves curling; old leaves of cultivar-specific colour
84	-	94	-
85	First fruits have cultivar-specific colour	95	-
86	-	96	-
87	Main harvest: more fruits coloured	97	Old leaves dead
88	-	98	-
89	Second harvest: more fruits coloured	99	-

1.3.17 Phenological growth stages and BBCH-identification keys of grapevine (*Vitis vinifera* L. ssp. *vinifera*), Lorenz et al., 1994

Code	Description	Code	Description
Principal growth stage 0: Sprouting/Bud development		**Principal growth stage 1: Leaf development**	
00	Dormancy: winter buds pointed to rounded, light or dark brown according to cultivar; bud scales more or less closed according to cultivar	10	-
01	Beginning of bud swelling: buds begin to expand inside the bud scales	11	First leaf unfolded and spread away from shoot
02	-	12	2nd leaves unfolded
03	End of bud swelling: buds swollen, but not green	13	3rd leaves unfolded
04	-	1 .	Stages continuous till ...
05	„Wool stage": brown wool clearly visible	19	9 or more leaves unfolded
06	-		
07	Beginning of bud burst: green shoot tips just visible		
08	Bud burst: green shoot tips clearly visible		
09	-		

Grapevine

Code	Description
Principal growth stage 2:	
Principal growth stage 3:	
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emerge	
50	-
51	-
52	-
53	Inflorescences clearly visible
54	-
55	Inflorescences swelling, flowers closely pressed together
56	-
57	Inflorescences fully developed; flowers separating
58	-
59	-

Code	Description
Principal growth stage 6: Flowering	
60	First flowerhoods detached from the receptacle
61	Beginning of flowering: 10 % of flowerhoods fallen
62	20 % of flowerhoods fallen
63	Early flowering: 30 % of flowerhoods fallen
64	40 % of flowerhoods fallen
65	Full flowering: 50 % of flowerhoods fallen
66	60 % of flowerhoods fallen
67	70 % of flowerhoods fallen
68	80 % of flowerhoods fallen
69	End of flowering

Grapevine

Code	Description	Code	Description
Principal growth stage 7: Development of fruits		**Principal growth stage 8: RIpening of berries**	
70	-	80	-
71	Fruit set: young fruits begin to swell, remains of flowers lost	81	Beginning of ripening: berries begin to develop variety-specific colour
72	-	82	-
73	Berries groat-sized, bunches begin to hang	83	Berries developing colour
74	-	84	-
75	Berries pea-sized, bunches hang	85	Softening of berries
76	-	86	-
77	Berries beginning to touch	87	-
78	-	88	-
79	Majority of berries touching	89	Berries ripe for harvest

Grapevine

Code	Description
Principal growth stage 9: Senescence	
90	-
91	After harvest; end of wood maturation
92	Beginning of leaf discolouration
93	Beginning of leaf-fall
94	-
95	50 % of leaves fallen
96	-
97	End of leaf-fall
98	-
99	Harvested product

1.3.18 Phenological growth stages and BBCH-identification keys of hop (*Humulus lupulus* L.), Rossbauer et al., 1995

Code	Description	Code	Description
Principal growth stage 0: Sprouting		**Principal growth stage 1: Leaf development**	
00	Dormancy: rootstock without shoots (uncut)	10	-
01	Dormancy: rootstock without shoots (cut)	11	First pair of leaves unfolded
02	-	12	2nd pair of leaves unfolded (beginning of twining)
03	-	13	3rd pair of leaves unfolded
04	-	1 .	Stages continuous till ...
05	-	19	9 and more pairs of leaves unfolded
06	-		
07	Rootstock with shoots (uncut)		
08	Beginning of shoot-growth (rootstock cut)		
09	Emergence: first shoots emerge at the soil surface		

Code	Description
Principal growth stage 2: Formation of side shoots	
20	-
21	First pair of side shoots visible
22	2nd pair of side shoots visible
23	3rd pair of side shoots visible
2 .	Stages continuous till ...
29	Nine and more pairs of side shoots visible (secondary side shoots occur)

Code	Description
Principal growth stage 3: Elongation of bines	
30	-
31	Bines have reached 10 % of top wire height
32	Bines have reached 20 % of top wire height
33	Bines have reached 30 % of top wire height
3 .	Stages continuous till ...
38	Plants have reached the top wire
39	End of bine growth

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	Inflorescence buds visible
52	-
53	-
54	-
55	Inflorescence buds enlarged
56	-
57	-
58	-
59	-

Code	Description
Principal growth stage 6: Flowering	
60	-
61	Beginning of flowering: about 10 % of flowers open
62	About 20 % of flowers open
63	About 30 % of flowers open
64	About 40 % of flowers open
65	Full flowering: about 50 % of flowers open
66	About 60 % of flowers open
67	About 70 % of flowers open
68	About 80 % of flowers open
69	End of flowering

Code	Description	Code	Description
Principal growth stage 7: Development of cones		**Principal growth stage 8: Maturity of cones**	
70	-	80	-
71	Beginning of cone development: 10 % of inflorescences are cones	81	Beginning of maturity: 10% of cones are compact
72	-	82	20 % of cones are compact
73	-	83	30 % of cones are compact
74	-	84	40 % of cones are compact
75	Cone development half way: all cones visible, cones soft, stigmas still present	85	Advanced maturity: 50 % of cones are compact
76	-	86	60 % of cones are compact
77	-	87	70 % of cones are compact
78	-	88	80 % of cones are compact
79	Cone development complete: nearly all cones have reached full size	89	Cones ripe for picking: cones closed; lupulin golden; aroma potential fully developed

Code	Description
Principal growth stage 9: Senescence, entry into dormancy	
90	-
91	-
92	Overripeness: cones yellow-brown discoloured, aroma deterioration
93	-
94	-
95	-
96	-
97	Dormancy: leaves and stems dead
98	-
99	-

1.3.19 Phenological growth stages and BBCH-identification keys of bulb vegetables (onion = *Allium cepa* L., leek = *Allium porrum* L., garlic = *Allium sativum* L., shallot = *Allium ascalonicum* auct. non L.), Feller et al., 1995 a

Code		Description	Code		Description
2- and 3digit			2- and 3digit		
Principal growth stage 0: Germination					
00	000	Dry seed,[1] dormant bulb [2]	08	008	-
01	000	Beginning of seed imbibition [1]	09	009	Emergence: cotyledon breaks through soil surface.[1] Green shoot visible [2]
02	002	-	-	010	Cotyledon visible as hook [1]
03	003	Seed imbibition complete [1]	-	011	Hook stage: hooked cotyledon green [1]
04	004	-	-	012	Whip stage: cotyledon has whip-like form [1]
05	005	Radicle emerged from seed.[1] Roots appearing [2]			
06	006	-			
07	007	Cotyledon breaking through seed coat [1]			

[1] *Seed sown*
[2] *Onion sets, shallot and garlic*

Code		Description
2- and 3digit		
Principal growth stage 1: Leaf development (Main shoot)		
10	100	Advanced whip stage: whip begins to die off [1]
11	101	First leaf (> 3 cm) clearly visible
12	102	2nd leaf (> 3cm) clearly visible
13	103	3rd leaf (> 3cm)
1 .	10 .	Stages continuous till ...
19	109	9 or more leaves clearly visible

Code		Description
2- and 3digit		
Principal growth stage 2:		
Principal growth stage 3:		
Principal growth stage 4:		**Development of harvestable vegetative plant parts**
40	400	-
41	401	Leaf bases begin to thicken or extend
42	402	-
43	403	30 % of the expected bulb or shaft diameter reached
44	404	-
45	405	50 % of the expected bulb or shaft diameter reached
46	406	-
47	407	Bolting begins; in 10 % of the plants leaves bent over [3] 70 % of the expected shaft length and diameter reached [4]
48	408	Leaves bent over in 50 % of plants [3]
49	409	Leaves dead, bulb top dry; dormancy [3] Growth complete; length and stem diameter typical for variety reached [4]

[1] *Seed sown*
[3] *For onions, garlic*
[4] *For leek*

Bulb vegetables

Code		Description	Code		Description
2- and 3digit			2- and 3digit		
Principal growth stage 5: Inflorescence emergence			**Principal growth stage 6: Flowering**		
50	500	-	60	600	First flowers open (sporadically)
51	501	Onion bulb begins to elongate	61	601	Beginning of flowering: 10 % of flowers open
52	502	-	62	602	20 % of flowers open
53	503	30 % of the expected length of flower stem reached	63	603	30 % of flowers open
54	504	-	64	604	40 % of flowers open
55	505	Flower stem at full length; sheath closed	65	605	Full flowering: 50 % of flowers open
56	506	-	66	606	-
57	507	Sheath burst open	67	607	Flowering finishing: 70 % of petals fallen or dry
58	508	-	68	608	-
59	509	First flower petals visible; flowers still closed	69	609	End of flowering

Code 2- and 3digit		Description	Code 2- and 3digit		Description
Principal growth stage 7: Development of fruit			**Principal growth stage 8: Ripening of fruit and seed**		
70	700	-	80	800	-
71	701	First capsules formed	81	801	Beginning of ripening: 10 % of capsules ripe
72	702	20 % of capsules formed	82	802	-
73	703	30 % of capsules formed	83	803	-
74	704	40 % of capsules formed	84	804	-
75	705	50 % of capsules formed	85	805	First capsules bursting
76	706	60 % of capsules formed	86	806	-
77	707	70 % of capsules formed	87	807	-
78	708	80 % of capsules formed	88	808	-
79	709	Capsule development complete; seeds pale	89	809	Fully ripe: seeds black and hard

Bulb vegetables

Code		Description
2- and 3digit		
Principal growth stage 9: Senescence		
90	900	-
91	901	-
92	902	Leaves and shoots beginning to discolour
93	903	-
94	904	-
95	905	50 % of leaves yellow or dead
96	906	-
97	907	Plants or above ground parts dead
98	908	-
99	909	Harvested product (seeds)

1.3.20 Phenological growth stages and BBCH-identification keys of root and stem vegetables (carrot = *Daucus carota* L. ssp. *sativus*, celeriac = *Apium graveolens* L. var. *rapaceum* Gaud., kohlrabi = *Brassica oleracea* L. var. *gongylodes*, chicory = *Cichorium intybus* var. *foliosum*, radish = *Raphanus sativus* L. ssp., swede = *Brassica napus* L. ssp. *rapifera* Metzg., scorzonera = *Scorzonera hispanica* L.), Feller et al., 1995 a

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development (Main shoot)**	
00	Dry seed	10	Cotyledons completely unfolded; growing point or true leaf initial visible
01	Beginning of seed imbibition	11	First true leaf unfolded
02	-	12	2nd true leaf unfolded
03	Seed imbibition complete	13	3rd true leaf unfolded
04	-	1.	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more true leaves unfolded
06	-		
07	Hypocotyl with cotyledons breaking through seed coat		
08	-		
09	Emergence: cotyledons break through soil surface		

Code	Description
Principal growth stage 2:	
Principal growth stage 3:	
Principal growth stage 4:	**Development of harvestable vegetative plant parts**
40	-
41	Roots beginning to expand (diameter > 0,5 cm)
42	20 % of the expected root diameter reached
43	30 % of the expected root diameter reached
44	40 % of the expected root diameter reached
45	50 % of the expected root diameter reached
46	60 % of the expected root diameter reached
47	70 % of the expected root diameter reached
48	80 % of the expected root diameter reached
49	Expansion complete; typical form and size of roots reached

Code	Description
Principal growth stage 5: Inflorescence emergence	
50	-
51	Main shoot begins to elongate
52	-
53	30 % of the expected height of the main shoot reached
54	-
55	First individual flowers of main inflorescence visible (still closed)
56	-
57	First individual flowers of secondary inflorescences visible (still closed)
58	-
59	First flower petals visible; flowers still closed

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open (sporadically)	70	-
61	Beginning of flowering: 10 % of flowers open	71	First fruits formed
62	20 % of flowers open	72	20 % of fruits have reached typical size
63	30 % of flowers open	73	30 % of fruits have reached typical size
64	40 % of flowers open	74	40 % of fruits have reached typical size
65	Full flowering: 50 % of flowers open	75	50 % of fruits have reached typical size
66	-	76	60 % of fruits have reached typical size
67	Flowering finishing: majority of petals fallen or dry	77	70 % of fruits have reached typical size
68	-	78	80 % of fruits have reached typical size
69	End of flowering	79	Fruits have reached typical size

Root and stem vegetables

Code	Description	Code	Description
Principal growth stage : Rispening of fruit and seed		***Principal growth stage 9: Senescence***	
80	-	90	-
81	Beginning of ripening: 10 % of fruits ripe, or 10 % of seeds of typical colour, dry and hard	91	-
82	-	92	Leaves and shoots beginning to discolour
83	-	93	-
84	-	94	-
85	50 % of the fruits ripe, or 50 % of seeds of typical colour, dry and hard	95	50 % of leaves yellow or dead
86	-	96	-
87	-	97	Plants or above ground parts dead
88	-	98	-
89	Fully ripe: seeds on the whole plant of typical colour and hard	99	Harvested product (seeds)

1.3.21 Phenological growth stages and BBCH-identification keys of leaf vegetables -forming heads- (cabbage = *Brassica oleracea* L. var. *capitata* f. *alba* and *rubra*, chinese cabbage = *Brassica chinensis* L., lettuce = *Lactuca sativa* L. var. *capitata*, endive = *Cichorium endivia* L.), Feller et al., 1995 a

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development (Main shoot)**	
00	Dry seed	10	Cotyledons completely unfolded; growing point or true leaf initial visible
01	Beginning of seed imbibition	11	First true leaf unfolded
02	-	12	2nd true leaf unfolded
03	Seed imbibition complete	13	3rd true leaf unfolded
04	-	1.	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more true leaves unfolded
06	-		
07	Hypocotyl with cotyledons breaking through seed coat		
08	-		
09	Emergence: cotyledons break through soil surface		

Leaf vegetables -forming heads-

Code	Description
Principal growth stage 2:	
Principal growth stage 3:	
Principal growth stage 4:	**Development of harvestable vegetative plant parts**
40	-
41	Heads begin to form: the two youngest leaves do not unfold
42	20 % of the expected head size reached
43	30 % of the expected head size reached
44	40 % of the expected head size reached
45	50 % of the expected head size reached
46	60 % of the expected head size reached
47	70 % of the expected head size reached
48	80 % of the expected head size reached
49	Typical size, form and firmness of heads reached

Code		Description
Principal growth stage 5: Inflorescence emergence		
50		-
51		Main shoot inside head begins to elongate
52		-
53		30 % of the expected height of the main shoot reached
54		-
55		First individual flowers of main inflorescence visible (still closed)
56		-
57		First individual flowers of secondary inflorescences visible (still closed)
58		-
59	59	First flower petals visible; flowers still closed

Leaf vegetables -forming heads-

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open (sporadically)	70	-
61	Beginning of flowering: 10 % of flowers open	71	First fruits formed
62	20 % of flowers open	72	20 % of fruits have reached typical size
63	30 % of flowers open	73	30 % of fruits have reached typical size
64	40 % of flowers open	74	40 % of fruits have reached typical size
65	Full flowering: 50 % of flowers open	75	50 % of fruits have reached typical size
66	-	76	60 % of fruits have reached typical size
67	Flowering finishing: majority of petals fallen or dry	77	70 % of fruits have reached typical size
68	-	78	80 % of fruits have reached typical size
69	End of flowering	79	Fruits have reached typical size

Leaf vegetables -forming heads-

Code	Description	Code	Description
Principal growth stage 8: Ripening of fruit and seed		**Principal growth stage 9: Senescence**	
80	-	90	-
81	Beginning of ripening: 10 % of fruits ripe, or 10 % of seeds of typical colour, dry and hard	91	-
82	20 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard	92	Leaves and shoots beginning to discolour
83	30 % of fruits ripe, or 30 % of seeds of typical colour, dry and hard	93	-
84	40 % of fruits ripe, or 40 % of seeds of typical colour, dry and hard	94	-
85	50 % of the fruits ripe, or 50 % of seeds of typical colour, dry and hard	95	50 % of leaves yellow or dead
86	60 % of fruits ripe, or 60 % of seeds of typical colour, dry and hard	96	-
87	70 % of fruits ripe, or 70 % of seeds of typical colour, dry and hard	97	Plants dead
88	80 % of fruits ripe, or 80 % of seeds of typical colour, dry and hard	98	-
89	Fully ripe: seeds on the whole plant of typical colour and hard	99	Harvested product (seeds)

1.3.22 Phenological growth stages and BBCH-identification keys of leaf vegetables -not forming heads- (spinach = *Spinacia oleracea* L., loosehead lettuce = *Lactuca sativa* L. var. *crispa*, kale = *Brassica oleracea* L. var. *sabellica*), Feller et al., 1995 a

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development (Main shoot)**	
00	Dry seed	10	Cotyledons completely unfolded; growing point or true leaf initial visible
01	Beginning of seed imbibition	11	First true leaf unfolded
02	-	12	2nd true leaf unfolded
03	Seed imbibition complete	13	3rd true leaf unfolded
04	-	1 .	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more true leaves unfolded
06	-		
07	Hypocotyl with cotyledons breaking through seed coat		
08	-		
09	Emergence: cotyledons break through soil surface		

Leaf vegetables -not forming heads-

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Stem elongation of rosette growth	
30	-
31	-
32	-
33	Leaf rosette has reached 30 % of the expected diameter typical for the variety.[1] Main shoot has reached 30 % of the expected height typical for the variety [2]
34	-
35	Leaf rosette has reached 50 % of the expected diameter typical for the variety.[1] Main shoot has reached 50 % of the expected height typical for the variety [2]
36	-
37	Leaf rosette has reached 70 % of the expected diameter typical for the variety.[1] Main shoot has reached 70 % of the expected height for the variety [2]
38	-
39	Rosette development completed [1] Main shoot has reached the height typical for the variety [2]

Code	Description
Principal growth stage 4: Development of harvestable vegetative plant parts	
40	-
41	10 % of the leaf mass typical for the variety reached
42	20 % of the leaf mass typical for the variety reached
43	30 % of the leaf mass typical for the variety reached
44	40 % of the leaf mass typical for the variety reached
45	50 % of the leaf mass typical for the variety reached
46	60 % of the leaf mass typical for the variety reached
47	70 % of the leaf mass typical for the variety reached
48	80 % of the leaf mass typical for the variety reached
49	Typical leaf mass reached

[1] *For letucce varieties without head, spinach and species with rosette-type growth*
[2] *For kale and species without rosette growth*

Leaf vegetables -not forming heads-

Code	Description	Code	Description
Principal growth stage 5: Inflorescence emergence		**Principal growth stage 6: Flowering**	
50	-	60	First flowers open (sporadically)
51	Main shoot begins to elongate [1] Main inflorescence visible between uppermost leaves[2]	61	Beginning of flowering: 10 % of flowers open
52	-	62	20 % of flowers open
53	30 % of the expected height of the main shoot reached	63	30 % of flowers open
54	-	64	40 % of flowers open
55	First individual flowers of main inflorescence visible (still closed)	65	Full flowering: 50 % of flowers open
56	-	66	-
57	-	67	Flowering finishing: majority of petals fallen or dry
58	-	68	-
59	First flower petals visible; flowers still closed	69	End of flowering

[1] *For letucce varieties without head, spinach and species with rosette-type growth*
[2] *For kale and species without rosette growth*

Leaf vegetables -not forming heads-

Code	Description	Code	Description
Principal growth stage 7: Development of fruit		**Principal growth stage 8: Ripening of fruit and seed**	
70	-	80	-
71	First fruits formed	81	Beginning of ripening: 10 % of fruits ripe, or 10 % of seeds of typical colour, dry and hard
72	20 % of fruits have reached typical size	82	20 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard
73	30 % of fruits have reached typical size	83	30 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard
74	40 % of fruits have reached typical size	84	40 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard
75	50 % of fruits have reached typical size	85	50 % of fruits ripe, or 50 % of seeds of typical colour, dry and hard
76	60 % of fruits have reached typical size	86	60 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard
77	70 % of fruits have reached typical size	87	70 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard
78	80 % of fruits have reached typical size	88	80 % of fruits ripe, or 20 % of seeds of typical colour, dry and hard
79	Fruits have reached typical size	89	Fully ripe: seeds on the whole plant of typical colour and hard

Leaf vegetables -not forming heads-

Code	Description
Principal growth stage 9: Senescence	
90	-
91	-
92	Leaves and shoots beginning to discolor
93	-
94	-
95	50 % of leaves yellow or dead
96	-
97	Plants dead
98	-
99	Harvested product (seeds)

1.3.23 Phenological growth stages and BBCH-identification keys of other brassica vegetables (brussels sprout = *Brassica oleracea* L. var. *gemmifera* DC./Zenk., cauliflower = *Brassica oleracea* L. var. *botrytis*, broccoli = *Brassica oleracea* L. var. *italica* Plenck), Feller et al., 1995 a

Code	Description
Principal growth stage 0: Germination	
00	Dry seed
01	Beginning of seed imbibition
02	-
03	Seed imbibition complete
04	-
05	Radicle emerged from seed
06	-
07	Hypocotyl with cotyledons breaking through seed coat
08	-
09	Emergence: cotyledons break through soil surface
Principal growth stage 1: Leaf development (Main shoot)	
10	Cotyledons completely unfolded; growing point or true leaf initial visible
11	First true leaf unfolded
12	2nd true leaf unfolded
13	3rd true leaf unfolded
1.	Stages continuous till ...
19	9 or more true leaves unfolded

Code	Description
Principal growth stage 2: Formation of side shoots	
20	
21	First side shoot visible [1]
22	2nd side shoot visible [1]
23	3rd side shoot visible [1]
2 .	Stages continuous till ...
29	9 or more side shoots visible [1]

Code	Description
Principal growth stage 3: Stem elongation of rosette growth	
30	
31	Main shoot has reached 10 % of the expected height typical for the variety [2]
32	Main shoot has reached 20 % of the expected height typical for the variety [2]
33	Main shoot has reached 30 % of the expected height typical for the variety [2]
34	Main shoot has reached 40 % of the expected height typical for the variety [2]
35	Main shoot has reached 50 % of the expected height typical for the variety [2]
36	Main shoot has reached 60 % of the expected height typical for the variety [2]
37	Main shoot has reached 70 % of the expected height typical for the variety [2]
38	Main shoot has reached 80 % of the expected height typical for the variety [2]
39	Main shoot has reached the height typical for the variety [2]

[1] *For broccoli*
[2] *For brussels sprout*

Other brassica vegetables

Code	Description	Code	Description
Principal growth stage 4: Development of harvestable vegetative plant parts		**Principal growth stage 5: Inflorescence emergence**	
40	-	50	-
41	Lateral buds begin to develop [2] Cauliflower heads begin to form;width of growing tip > 1 cm [3]	51	Main inflorescence visible between uppermost leaves [2] Branches of inflorescence begin to elongate [3]
42	-	52	-
43	First sprouts tightly closed [2] 30 % of the expected head diameter reached [3]	53	-
44	-	54	-
45	50 % of the sprouts tightly closed [2] 50 % of the expected head diameter reached [3]	55	First individual flowers visible (still closed)
46	60 % of the sprouts tightly closed [2] 60 % of the expected head diameter reached [3]	56	-
47	70 % of the sprouts tightly closed [2] 70 % of the expected head diameter reached [3]	57	-
48	80 % of the sprouts tightly closed [2] 80 % of the expected head diameter reached [3]	58	-
49	Sprouts below terminal bud tightly closed [2] Typical size and form reached; head tightly closed [3]	59	First flower petals visible; flowers still closed

[2] *For brussels sprout*

[3] *For cauliflower and broccoli*

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open (sporadically)	70	-
61	Beginning of flowering: 10 % of flowers open	71	First fruits formed
62	20 % of flowers open	72	20 % of fruits have reached typical size
63	30 % of flowers open	73	30 % of fruits have reached typical size
64	40 % of flowers open	74	40 % of fruits have reached typical size
65	Full flowering: 50 % of flowers open	75	50 % of fruits have reached typical size
66	-	76	60 % of fruits have reached typical size
67	Flowering finishing: majority of petals fallen or dry	77	70 % of fruits have reached typical size
68	-	78	80 % of fruits have reached typical size
69	End of flowering	79	Fruits have reached typical size

Other brassica vegetables

Code	Description	Code	Description
Principal growth stage 8: Ripening of fruit and seed		**Principal growth stage 9: Senescence**	
80	-	90	-
81	Beginning of ripening: 10 % of fruits ripe	91	-
82	20 % of fruits ripe	92	Leaves and shoots beginning to discolour
83	30 % of fruits ripe	93	-
84	40 % of fruits ripe	94	-
85	50 % of fruits ripe	95	50 % of leaves yellow or dead
86	60 % of fruits ripe	96	-
87	70 % of fruits ripe	97	Plants dead
88	80 % of fruits ripe	98	-
89	Fully ripe: seeds on the whole plant of typical color and hard	99	Harvested product (seeds)

1.3.24 Phenological growth stages and BBCH-identification keys of cucurbits (cucumber = *Cucumis sativus* L., melon = *Cucumis melo* L., pumpkin, marrow, squash = *Cucurbita pepo* L., calabash = *Cucurbita pepo* L. var. *giromontiina* Alef./Greb, water-melon = *Citrullus* var. *vulgaris* Schad.), Feller et al., 1995 b

Code		Description	Code		Description
2 -and 3digit			2- and 3digit		
Principal growth stage 0: Germination			**Principal growth stage 1: Leaf development**		
00	000	Dry seed	10	100	Cotyledons completely unfolded
01	001	Beginning of seed imbibition	11	101	First true leaf on main stem fully unfolded
02	002	-	12	102	2nd true leaf on main stem unfolded
03	003	Seed imbibition complete	13	103	3rd true leaf on main stem unfolded
04	004	-	1 .	10 .	Stages continuous till ...
05	005	Radicle emerged from seed	19	109	9 or more leaves on main stem unfolded (2digit) 9th leaf unfolded on main stem (3digit)
06	006	-	-	110	10th leaf on main stem unfolded
07	007	Hypocotyl with cotyledons breaking through seed coat	-	11 .	Stages continuous till ...
08	008	-	-	119	19th leaf on main stem unfolded
09	009	Emergence: cotyledons break through soil surface			

Code		Description
2 -and 3digit		
Principal growth stage 2: Formation of side shoots		
20	200	-
21	201	First primary side shoot visible
22	202	2nd primary side shoot visible
2 .	20 .	Stages continuous till ...
29	209	9 or more primary side shoots visible
-	221	First secondary side shoot visible
-	22 .	Stages continuous till ...
-	229	9th secondary side shoot visible
-	231	First tertiary side shoot visible

Code		Description
2- and 3digit		
Principal growth stage 3: ——		
Principal growth stage 4: ——		
Principal growth stage 5: Inflorescence emergence		
50	500	-
51	501	First flower initial with elongated ovary visible on main stem
52	502	2nd flower initial with elongated ovary visible on main stem
53	503	3rd flower initial with elongated ovary visible on main stem
5 .	50 .	Stages continuous till ...
59	509	9 or more flower initials with elongated ovary already visible on main stem
-	510	10 or more flower initials with elongated ovary already visible on main stem
-	51 .	Stages continuous till ...
-	519	19 ore more flower initials with elongated ovary already visible on main stem
-	521	First flower initial visible on a secondary side shoot
-	531	First flower initial visible on a tertiary side shoot

Cucurbits

Code		Description	Code		Description
2 -and 3digit			2- and 3digit		
Principal growth stage 6: Flowering			**Principal growth stage 7: Development of fruit**		
60	600	-	70	700	-
61	601	First flower open on main stem	71	701	First fruit on main stem has reached typical size and form
62	602	2nd flower open on main stem	72	702	2nd fruit on main stem has reached typical size and form
63	603	3rd flower open on main stem	73	703	3rd fruit on main stem has reached typical size and form
6 .	60 .	Stages continuous till ...	7 .	70 .	Stages continuous till ...
69	609	9th flower open on main stem or 9 flowers on main stem already open	79	709	9 or more fruits on main stem has reached typical size and form
-	610	10th flower open on main stem or 10 flowers on main stem already open	-	721	First fruit on a secondary side shoot has reached typical size and form
-	61 .	Stages continuous till ...	-	731	First fruit on a tertiary side shoot has reached typical size and form
-	619	19th flower open on man stem ore more than 19 flowers on main stem already open			
-	621	First flower on secondary side shoot open			
-	631	First flower on tertiary side shoot open			

Cucurbits

Code		Description	Code		Description
2 -and 3digit			2- and 3digit		
Principal growth stage 8: Ripening of fruit and seed			**Principal growth stage 9: Senescence**		
80	800	-	90	900	-
81	801	10 % of fruits show typical fully ripe colour	91	901	-
82	802	20 % of fruits show typical fully ripe colour	92	902	-
83	803	30 % of fruits show typical fully ripe colour	93	903	-
84	804	40 % of fruits show typical fully ripe colour	94	904	-
85	805	50 % of fruits show typical fully ripe colour	95	905	-
86	806	60 % of fruits show typical fully ripe colour	96	906	-
87	807	70 % of fruits show typical fully ripe colour	97	907	Plants dead
88	808	80 % of fruits show typical fully ripe colour	98	908	-
89	809	Fully ripe: fruits have typical fully ripe colour	99	909	Harvested product (seeds)

1.3.25 Phenological growth stages and BBCH-identification keys of solanaceous fruits (tomato = *Lycopersicon esculentum* Mill., aubergine = *Solanum melongena* L., paprika = *Capsicum annuum* L), Feller et al., 1995 b

Code		Description	Code		Description
2 -and 3digit			2- and 3digit		
Principal growth stage 0: Germination			**Principal growth stage 1: Leaf development**		
00	000	Dry seeds	10	100	Cotyledons completely unfolded
01	001	Beginning of seed imbibition	11	101	First true leaf on main shoot fully unfolded
02	002	-	12	102	2nd leaf on main shoot unfolded
03	003	Seed imbibition complete	13	103	3rd leaf on main shoot unfolded
04	004	-	1 .	10 .	Stages continuous till ...
05	005	Radicle emerged from seed	19	109	9 or more leaves on main shoot unfolded
06	006	-			
07	007	Hypocotyl with cotyledons breaking through seed coat			
08	008	-			
09	009	Emergence: coryledons break through soil surface			

Code		Description
2 -and 3digit		
Principal growth stage 2: Formation of side shoots [1]		
20	200	-
21	201	First primary apical side shoot visible
22	202	2nd primary apical side shoot visible
2 .	20 .	Stages continuous till ...
29	209	9 or more apical primary side shoots visible
-	221	First secondary apical side shoot visible
-	22 .	Stages continuous till ...
-	229	9th secondary apical side shoot visible
-	231	First tertiary apical side shoot visible
-	23 .	Stages continuous till ...
-	2NX	Xth apical side shoot of the Nth order visible

Code		Description
2- and 3digit		
Principal growth stage 3: ———		
Principal growth stage 4: ———		
Principal growth stage 5: Inflorescence emergence		
50	500	-
51	501	First inflorescence visible (first bud erect) [2] First flower bud visible [3]
52	502	2nd inflorescence visible (first bud erect) [2] 2nd flower bud visible [3]
53	503	3th inflorescence visible (first bud erect) [2] 3th flower bud visible [3]
5 .	50 .	Stages continuous till ...
59	509	9 or more inflorescences visible (2digit), 9th inflorescence visible(first bud erect) (3digit) [2] 9 or more flower buds already visible (2digit), 9th flower bud visible (3digit) [3]
-	510	10th inflorescence visible (first bud erect) [2] 10th flower bud visible [3]
-	51 .	Stages continuous till ...
-	519	19th inflorescence visible (first bud erect) [2] 19th flower bud visible [3]

[1] *For tomatoes with determinate stem growth, paprika and aubergines. In tomatoes with indeterminate stem growth and only one sympodial branch at the corresponding axis, the apical side shoot formation occurs concurrently with the emergence of the inflorescence (Principal growth stage 5), so that the coding within principal growth stage 2 is not necessary*

[2] *For tomato*

[3] *For paprika and aubergine*

Solanaceous fruits

Code		Description	Code		Description
2 -and 3digit		**Principal growth stage 6: Flowering**	2- and 3digit		**Principal growth stage 7: Development of fruit**
60	600	-	70	700	-
61	601	First inflorescence: first flower open [2] First flower open [3]	71	701	First fruit cluster: first fruit has reached typical size [2] First fruit has reached typical size and form [3]
62	602	2nd inflorescence: first flower open [2] 2nd flower open [3]	72	702	2nd fruit cluster: first fruit has reached typical size [2] 2nd fruit has reached typical size and form [3]
63	603	3rd inflorescence: first flower open [2] 3rd flower open [3]	73	703	3rd fruit cluster: first fruit has reached typical size [2] 3rd fruit has reached typical size and form [3]
6 .	60 .	Stages continuous till ...	7 .	70 .	Stages continuous till ...
69	609	9 or more inflorescences with open flowers (2digit) 9th inflorescence: first flower open (3digit) [2] 9 or more flowers already open (2digit) 9th flower open (3digit) [3]	79	709	9 or more fruit clusters with fruits of typical size (2digit) 9th fruit cluster:first fruit has reached typical size (3digit) [2] 9 or more fruits have reached typical size and form (2digit) 9th fruit has reached typical size and form(3digit) [3]
-	610	10th inflorescence: first flower open [2] 10th flower open [3]	-	710	10th fruit cluster: first fruit has reached typical form and size [2] 10th fruit has reached typical form and size [3]
-	61 .	Stages continuous till ...	-	71 .	Stages continuous till ... 19th fruit has reached typical form and size [3]
-	619	19th inflorescence: first flower open [2] 19th flower open [3]	-	719	19th fruit cluster: first fruit has reached typical form and size [2]

[2] *For tomato*
[3] *For paprika and aubergine*

Solanaceous fruits

Code		Description	Code		Description
2 -and 3digit			2- and 3digit		
Principal growth stage 8: Ripening of fruit and seed			**Principal growth stage 9: Senescence**		
80	800	-	90	901	-
81	801	10 % of fruits show typical fully ripe colour	91	901	-
82	802	20 % of fruits show typical fully ripe colour	92	902	-
83	803	30 % of fruits show typical fully ripe colour	93	903	-
84	804	40 % of fruits show typical fully ripe colour	94	904	-
85	805	50 % of fruits show typical fully ripe colour	95	905	-
86	806	60 % of fruits show typical fully ripe colour	96	906	-
87	807	70 % of fruits show typical fully ripe colour	97	907	Plants dead
88	808	80 % of fruits show typical fully ripe colour	98	908	-
89	809	Fully ripe: fruits have typical fully ripe colour [3]	99	909	Harvested product

[3] *For paprika and aubergines*

1.3.26 Phenological growth stages and BBCH-identification keys of pea (*Pisum sativum* L.), Weber and Bleiholder, 1990; Feller et al., 1995 b

Code	Description
Principal growth stage 0: Germination	
00	Dry seed
01	Beginning of seed imbibition
02	-
03	Seed imbibition complete
04	-
05	Radicle emerged from seed
06	-
07	Shoot breaking through seed coat
08	Shoot growing towards soil surface; hypocotyl arch visible
09	Emergence: shoot breaks through soil surface ("cracking stage")

Code	Description
Principal growth stage 1: Leaf development	
10	Pair of scale leaves visible
11	First true leaf (with stipules) unfolded or first tendril developed
12	2 leaves (with stipules) unfolded or 2 tendrils developed
13	3 leaves (with stipules) unfolded or 3 tendrils developed
1 .	Stages continuous till ...
19	9 or more leaves (with stipules) unfolded or 9 or more tendrils developed

Code	Description
Principal growth stage 2:	
Principal growth stage 3: Stem elongation (Main shoot)	
30	Beginning of stem elongation
31	1 visibly extended internode [1]
32	2 visibly extended internodes [1]
33	3 visibly extended internodes [1]
3 .	Stages continuous till ...
39	9 or more visibly extended internodes [1]

Code	Description
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	First flower buds visible outside leaves
52	-
53	-
54	-
55	First separated flower buds visible outside leaves but still closed
56	-
57	-
58	-
59	First petals visible, flowers still closed

[1] *The first internode extends from the scale leaf node to the first true leaf node*

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open (sporadically within the population)	70	-
61	Beginning of flowering: 10 % of flowers open	71	10 % of pods have reached typical length; juice exudes if pressed
62	20 % of flowers open	72	20 % of pods have reached typical length; juice exudes if pressed
63	30 % of flowers open	73	30 % of pods have reached typical length; juice exudes if pressed.Tenderometer value: 80 TE
64	40 % of flowers open	74	40 % of pods have reached typical length; juice exudes if pressed.Tenderometer value: 95 TE
65	Full flowering: 50 % of flowers open	75	50 % of pods have reached typical length; juice exudes if pressed.Tenderometer value: 105 TE
66	-	76	60 % of pods have reached typical length; juice exudes if pressed.Tenderometer value: 115 TE
67	Flowering declining	77	70 % of pods have reached typical length. Tenderometer value: 130 TE
68	-	78	-
69	End of flowering	79	Pods have reached typical size (green ripe); peas fully formed

Pea

Code	Description	Code	Description
Principal growth stage 8: Ripening of fruit and seed		**Principal growth stage 9: Senescence**	
80	-	90	-
81	10 % of pods ripe, seeds final colour, dry and hard	91	-
82	20 % of pods ripe, seeds final colour, dry and hard	92	-
83	30 % of pods ripe, seeds final colour, dry and hard	93	-
84	40 % of pods ripe, seeds final colour, dry and hard	94	-
85	50 % of pods ripe, seeds final colour, dry and hard	95	-
86	60 % of pods ripe, seeds final colour, dry and hard	96	-
87	70 % of pods ripe, seeds final colour, dry and hard	97	Plants dead and dry
88	80 % of pods ripe, seeds final colour, dry and hard	98	-
89	Fully ripe: all pods dry and brown. Seeds dry and hard (dry ripe)	99	Harvested product

1.3.27 Phenological growth stages and BBCH-identification keys of Bean (*Phaseolus vulgaris* var. *nanus* L.), Feller et al., 1995 b

Code	Description	Code	Description
Principal growth stage 0: Germination		**Principal growth stage 1: Leaf development**	
00	Dry seed	10	Cotyledons completely unfolded
01	Beginning of seed imbibition	11	-
02	-	12	2 full leaves (first leaf pair unfolded)
03	Seed imbibition complete	13	3rd true leaf (first trifoliate leaf) unfolded
04	-	1.	Stages continuous till ...
05	Radicle emerged from seed	19	9 or more leaves (2 full leaves, 7 or more trifoliate) unfolded
06	-		
07	Hypocotyl with cotyledons breaking through seed coat		
08	Hypocotyl reaches the soil surface; hypocotyl arch visible		
09	Emergence: hypocotyl with cotyledons break through soil surface ("cracking stage")		

Code	Description
Principal growth stage 2: Formation of side shoots	
20	-
21	First side shoot visible
22	2nd side shoot visible
23	3rd side shoot visible
2.	Stages continuous till ...
29	9 or more side shoots visible
Principal growth stage 3:	
Principal growth stage 4:	
Principal growth stage 5: Inflorescence emergence	
50	-
51	First flower buds visible
52	-
53	-
54	-
55	First flower buds enlarged
56	-
57	-
58	-
59	First petals visible, flowers still closed

Code	Description	Code	Description
Principal growth stage 6: Flowering		**Principal growth stage 7: Development of fruit**	
60	First flowers open (sporadically within the population)	70	-
61	Beginning of flowering: 10 % of flowers open [1] Beginning of flowering [2]	71	10 % of pods have reached typical length [1] Beginning of pot development [2]
62	20 % of flowers open [1]	72	20 % of pods have reached typical length [1]
63	30 % of flowers open [1]	73	30 % of pods have reached typical length [1]
64	40 % of flowers open [1]	74	40 % of pods have reached typical length [1]
65	Full flowering: 50 % of flowers open [1] Main flowering period [2]	75	50 % of pods have reached typical length, beans beginning to fill out [1] Main pod development period [2]
66	-	76	60 % of pods have reached typical length [1]
67	Flowering finishing: majority of petals fallen or dry [1]	77	70 % of pods have reached typical length, pods still break cleanly [1]
68	-	78	80 % of pods have reached typical length [1]
69	End of flowering: first pods visible [1]	79	Pods: individual beans easily visible [1]

[1] *For vari* *limited flowering period*
[2] *For varieties in which the flowering period is not limited*

Code	Description	Code	Description
Principal growth stage 8: Ripening of fruit and seed		**Principal growth stage 9: Senescence**	
80	-	90	-
81	10 % of pods ripe (beans hard) [1] Seeds beginning to mature [2]	91	-
82	20 % of pods ripe (beans hard) [1]	92	-
83	30 % of pods ripe (beans hard) [1]	93	-
84	40 % of pods ripe (beans hard) [1]	94	-
85	50 % of pods ripe (beans hard) [1] Main period of ripening [2]	95	-
86	60 % of pods ripe (beans hard) [1]	96	-
87	70 % of pods ripe (beans hard) [1]	97	Plants dead
88	80 % of pods ripe (beans hard) [1]	98	-
89	Fully ripe: pods ripe (beans hard) [1]	99	Harvested product

[1] *For varieties with limited flowering period*
[2] *For varieties in which the flowering period is not limited*

1.3.28 Phenological growth stages and BBCH-identification keys of weed species

D = **D**icotyledons, G = **G**ramineae, M = **M**onocotyledons, P = **P**erennial plants, V = Development from **v**egetative parts or propagated organs.
No code letter is used if the description applies to all groups of plants.

Code		Description
Principal growth stage 0: Germination, sprouting, bud development		
00		Dry seed
	V	Perennating or reproductive organs during the resting period (tuber, rhizome, bulb, stolon)
	P	Winter dormancy or resting period
01		Beginning of seed imbibition
	P, V	Beginning of bud swelling
02		-
03		Seed imbibition complete
	P, V	End of bud swelling
04		-
05		Radicle (root) emerged from seed
	V	Perennating or reproductive organs forming roots
06		Elongation of radicle, formation of root hairs and/or lateral roots
07	G	Coleoptile emerged from caryopsis
	D, M	Hypocotyl with cotyledons or shoot breaking through seed coat
	P, V	Beginning of sprouting or bud breaking
08	D	Hypocotyl with cotyledons or shoot growing towards soil surface
	V	Shoot growing towards soil surface
09	G	*Emergence:* Coleoptile breaks through soil surface
	D, M	*Emergence:* Cotyledons break through soil surface (except hypogeal germination);
	V	*Emergence:* Shoot/Leaf breaks through soil surface
	P	Buds show green tips

Code		Description
Principal growth stage 1: Leaf development (main shoot)		
10	G, M	First true leaf emerged from coleoptile
	D	Cotyledons completely unfolded
	P	First leaves separated
11		First true leaf, leaf pair or whorl unfolded
	P	First leaves unfolded
12		2 true leaves, leaf pairs or whorls unfolded
13		3 true leaves, leaf pairs or whorls unfolded
1 .		Stages continuous *till* ...
19		9 or more true leaves, leaf pairs or whorls unfolded

Weed species

Code		Description	Code		Description
Principal growth stage 2: Formation of side shoots/tillering			**Principal growth stage 3: Stem elongation/shoot development (main shoot)**		
20		-	30		Beginning of stem elongation
				G	Beginning of shooting
21		First side shoot visible	31		1 visibly extended internode
	G	First tiller visible		G	1 node stage
22		2 side shoots visible	32		2 visibly extended internode;
	G	2 tillers visible		G	2 node stage
23		3 side shoots visible	33		3 visibly extended internode
	G	3 tillers visible		G	3 node stage
2 .		Stages continuous till ...	3 .		Stages continuous till ...
29		9 or more side shoots visible	39		9 or more visibly extended internodes
	G	9 or more tillers visible		G	9 or more nodes

Code		Description	Code		Description
Principal growth stage 4: vegetative propagation/ booting (main shoot)			**Principal growth stage 5: Inflorescence emergence (main shoot)/heading**		
40	V	Vegetative reproductive organs begin to develop (rhizomes, stolons, tubers, runners, bulbs)	50		-
41	G	Flag leaf sheath extending	51		Inflorescence or flower buds visible
				G	Beginning of heading
42	V	First young plant visible	52		-
43	G	Flag leaf sheath just visibly swollen (mid-boot)	53		-
44		-	54		-
45	G	Flag leaf sheath swollen (late-boot)	55		First individual flowers visible (still closed)
				G	Half of inflorescence emerged (middle of heading)
46		-	56		-
47	G	Flag leaf sheath opening	57		-
48		-	58		-
49	V	Constant new development of young plants; vegetative reproductive organs reach final size	59		First flower petals visible (in petalled forms)
	G	First awns visible		G	Inflorescence fully emerged (end of heading)

Code	Description	Code	Description
Principal growth stage 6: Flowering (main shoot)		**Principal growth stage 7: Development of fruit**	
60	First flowers open (sporadically)	70	-
61	Beginning of flowering: 10 % of flowers open	71 G	Fruits begin to develop Caryopsis watery ripe
62	-	72	-
63	30 % of flowers open	73	-
64	-	74	-
65	Full flowering: 50 % of flowers open, first petals may be fallen	75	-
66	-	76	-
67	Flowering finishing: majority of petals fallen or dry	77	-
68	-	78	-
69	End of flowering: fruit set visible	79	Nearly all fruits have reached final size normal for the species and location

Code	Description	Code	Description
Principal growth stage 8: Ripening or maturity of fruit and seed		**Principal growth stage 9: Senescence, beginning of dormancy**	
80	-	90	-
81	Beginning of ripening or fruit coloration	91	-
82	-	92	-
83	-	93	-
84	-	94	-
85	-	95	-
86	-	96	-
87	-	97 P, V	End of leaf fall, plants or above ground parts dead or dormant; Plant resting or dormant
88	-	98	-
89	Fully ripe	99	-

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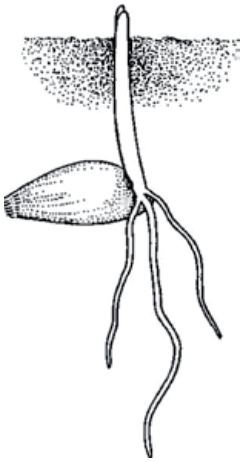

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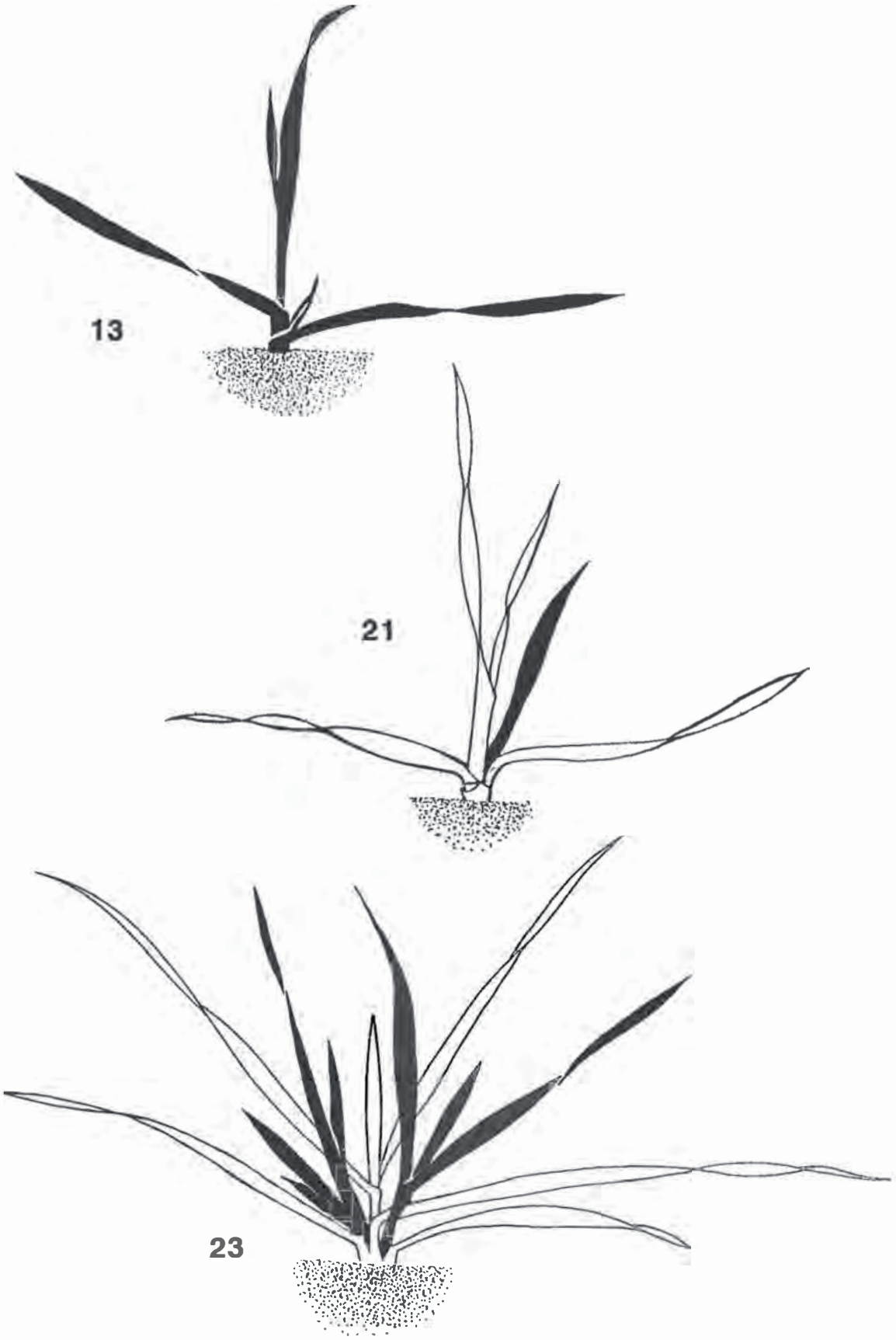

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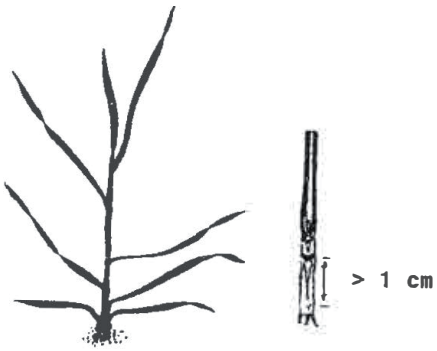

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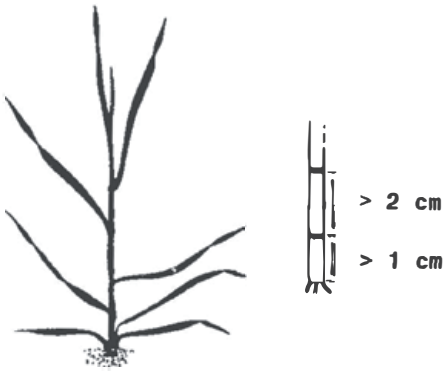

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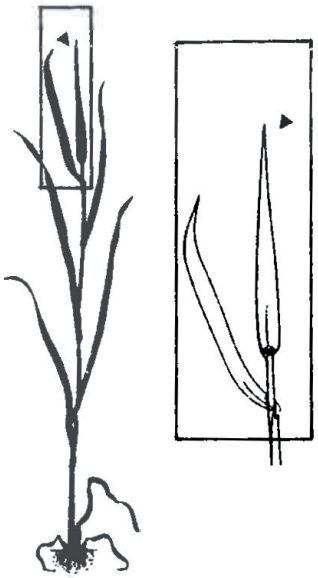

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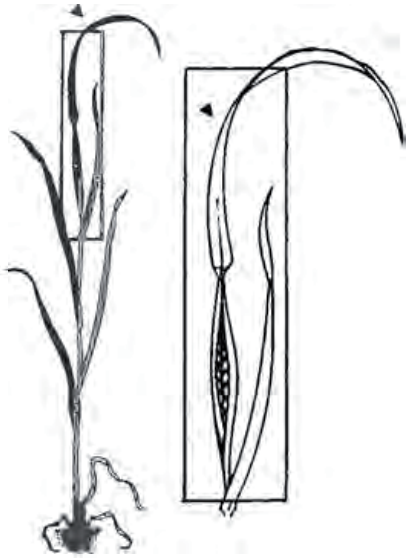

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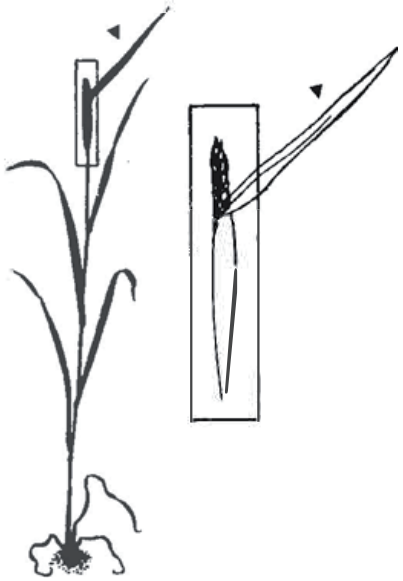

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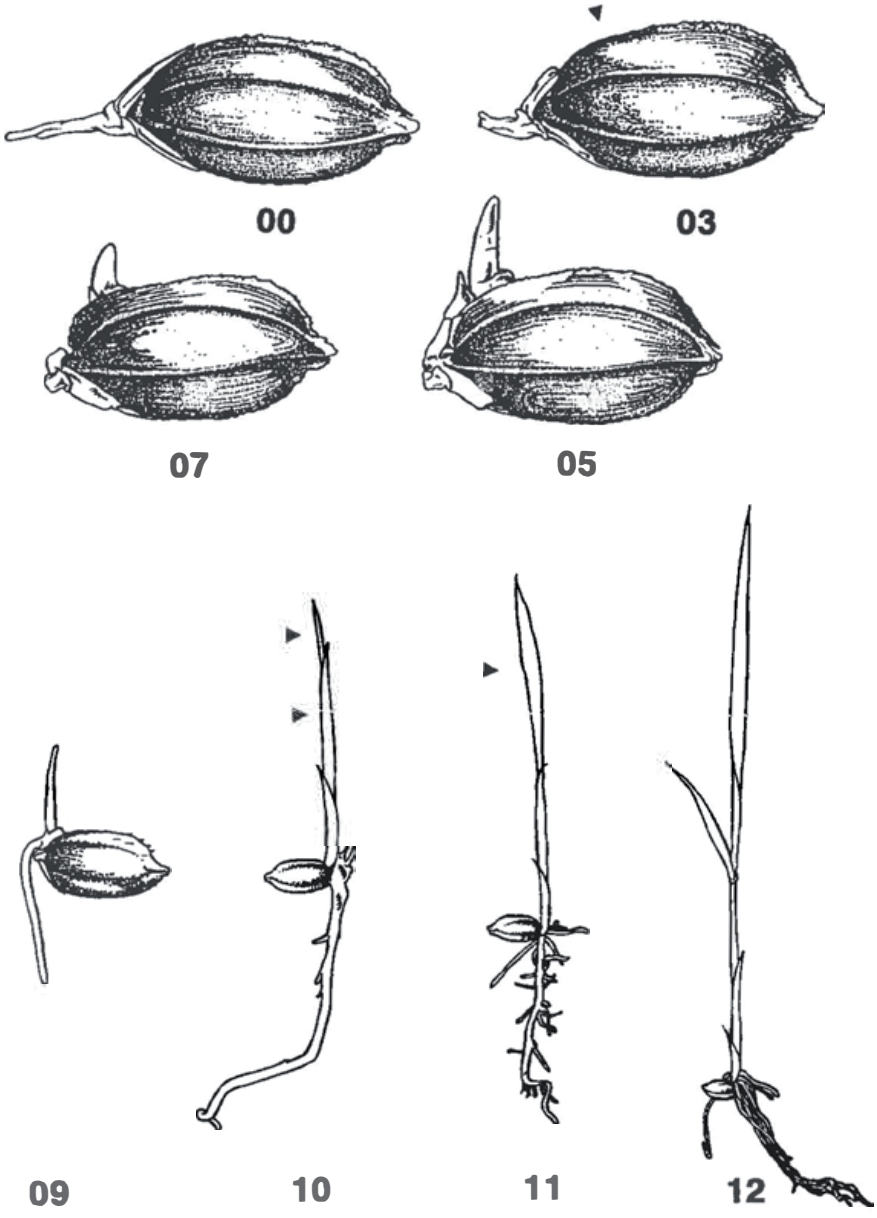

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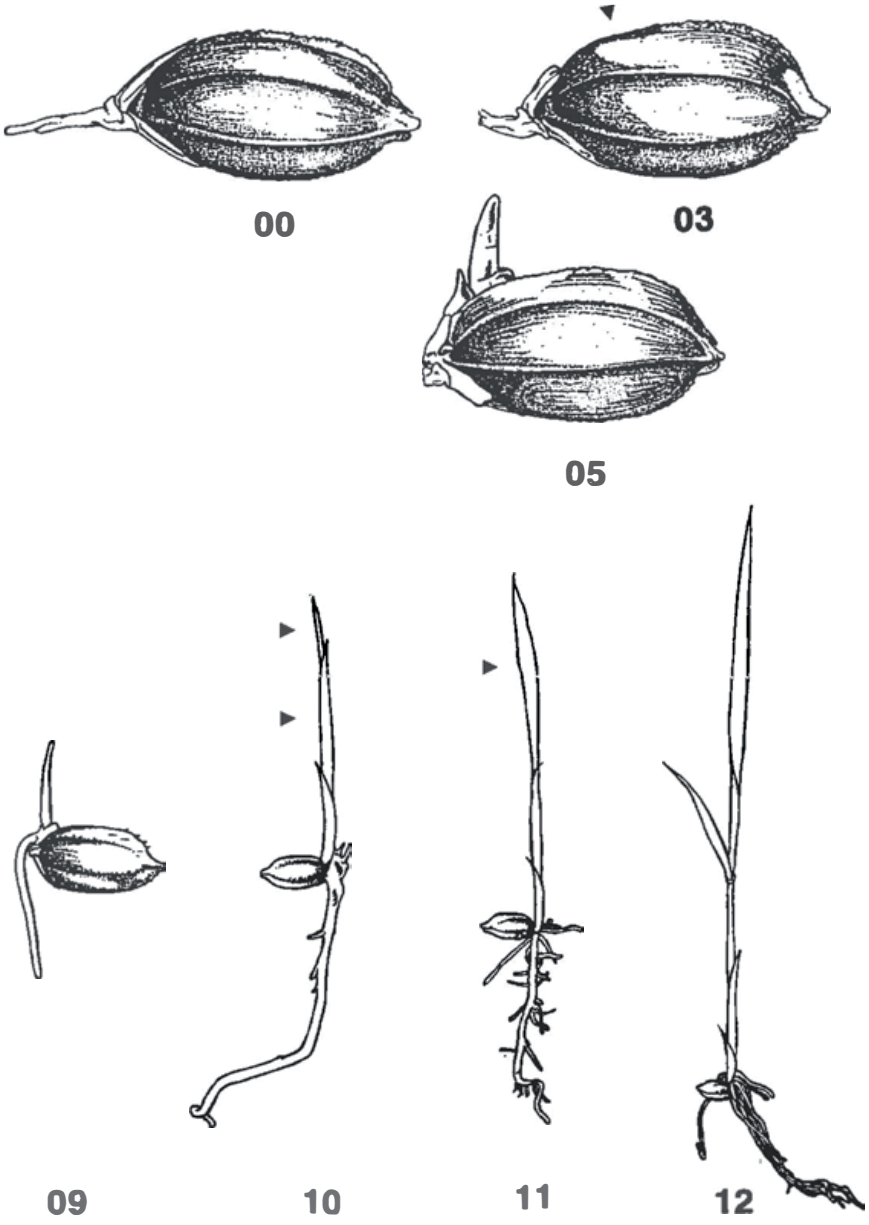

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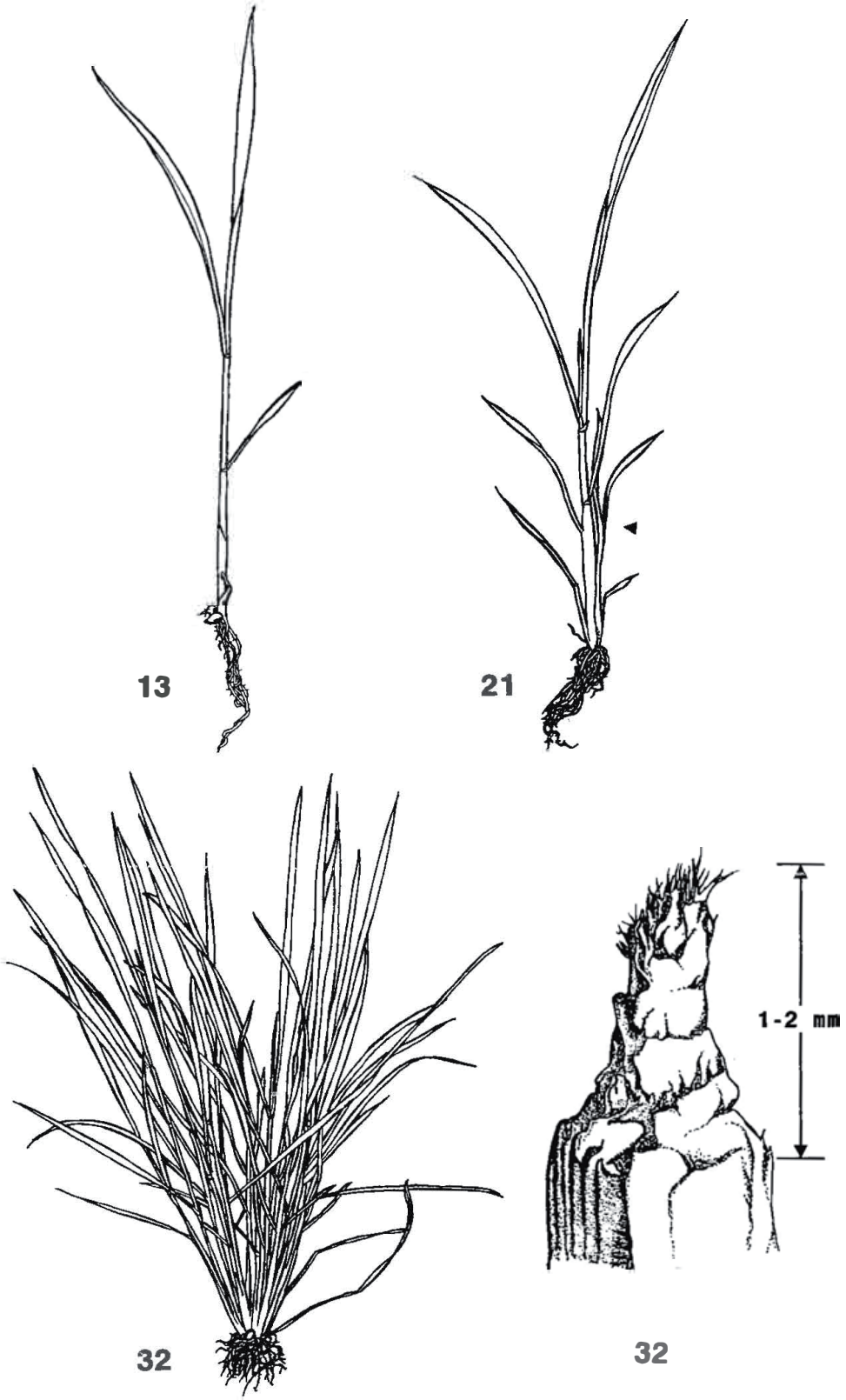

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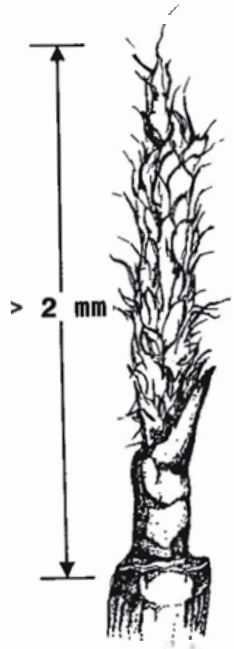

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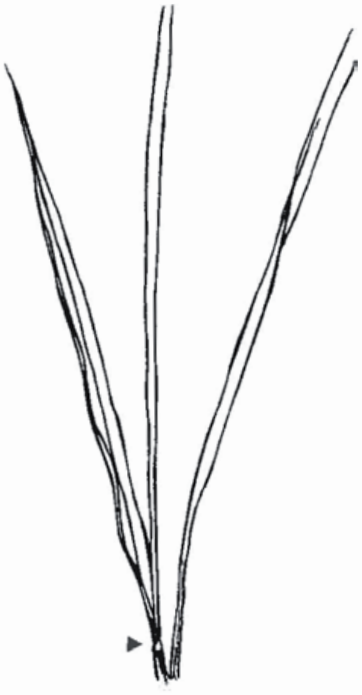

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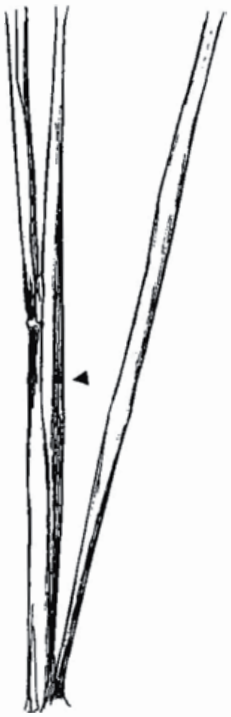

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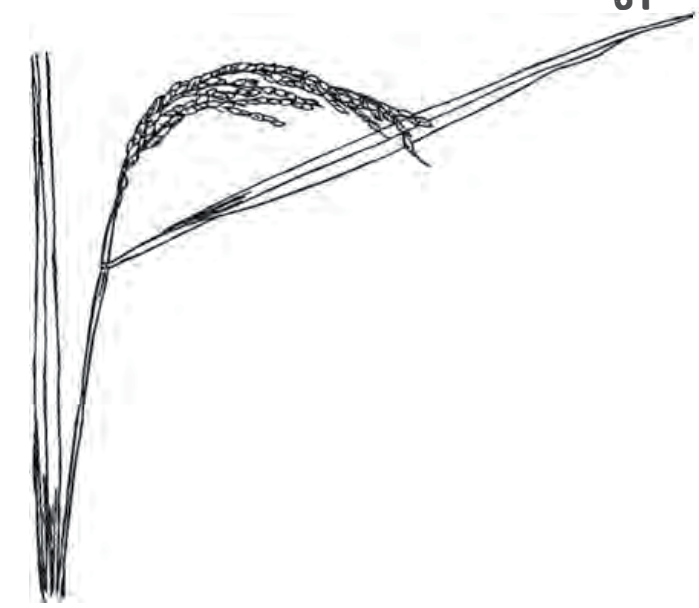

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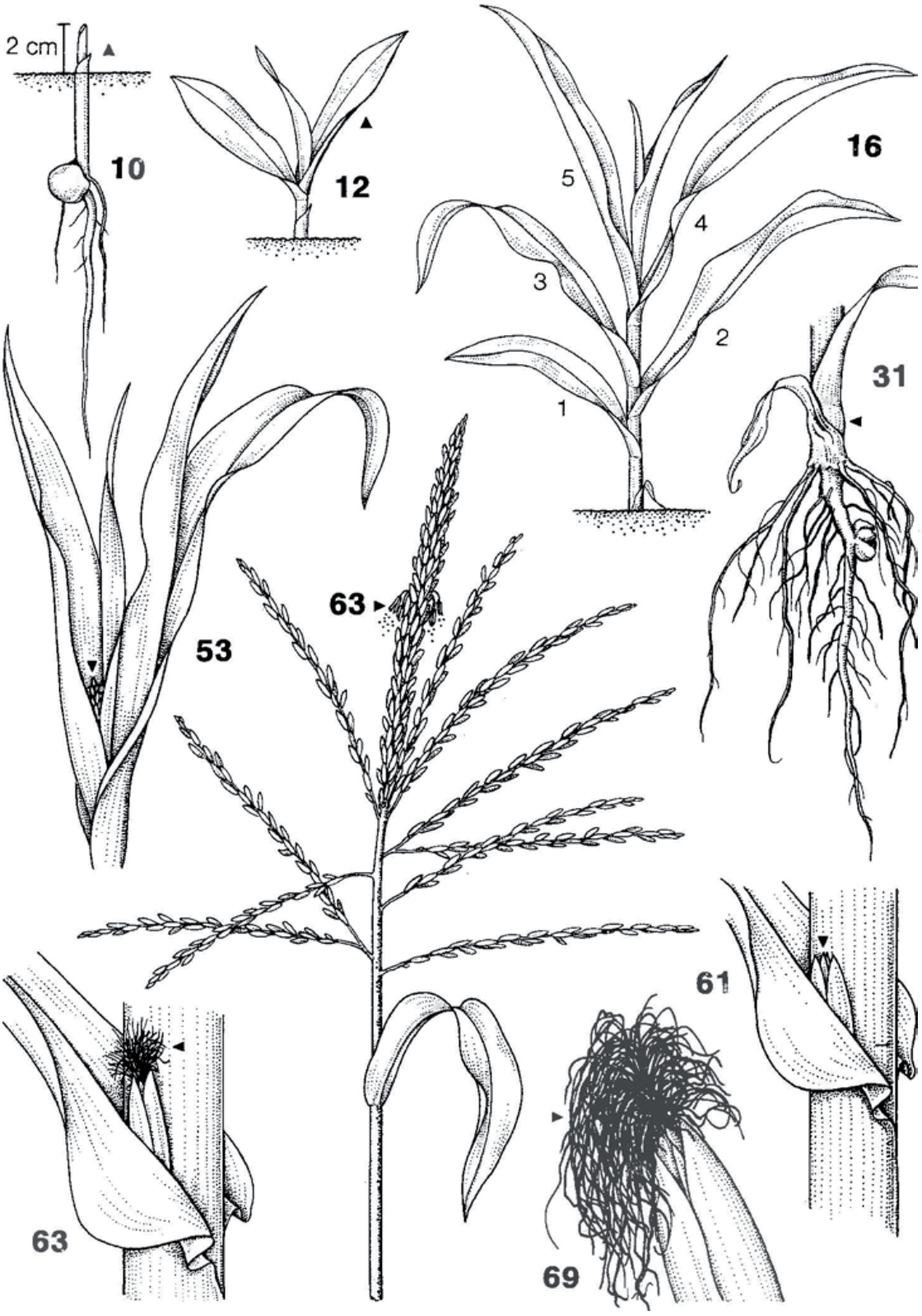

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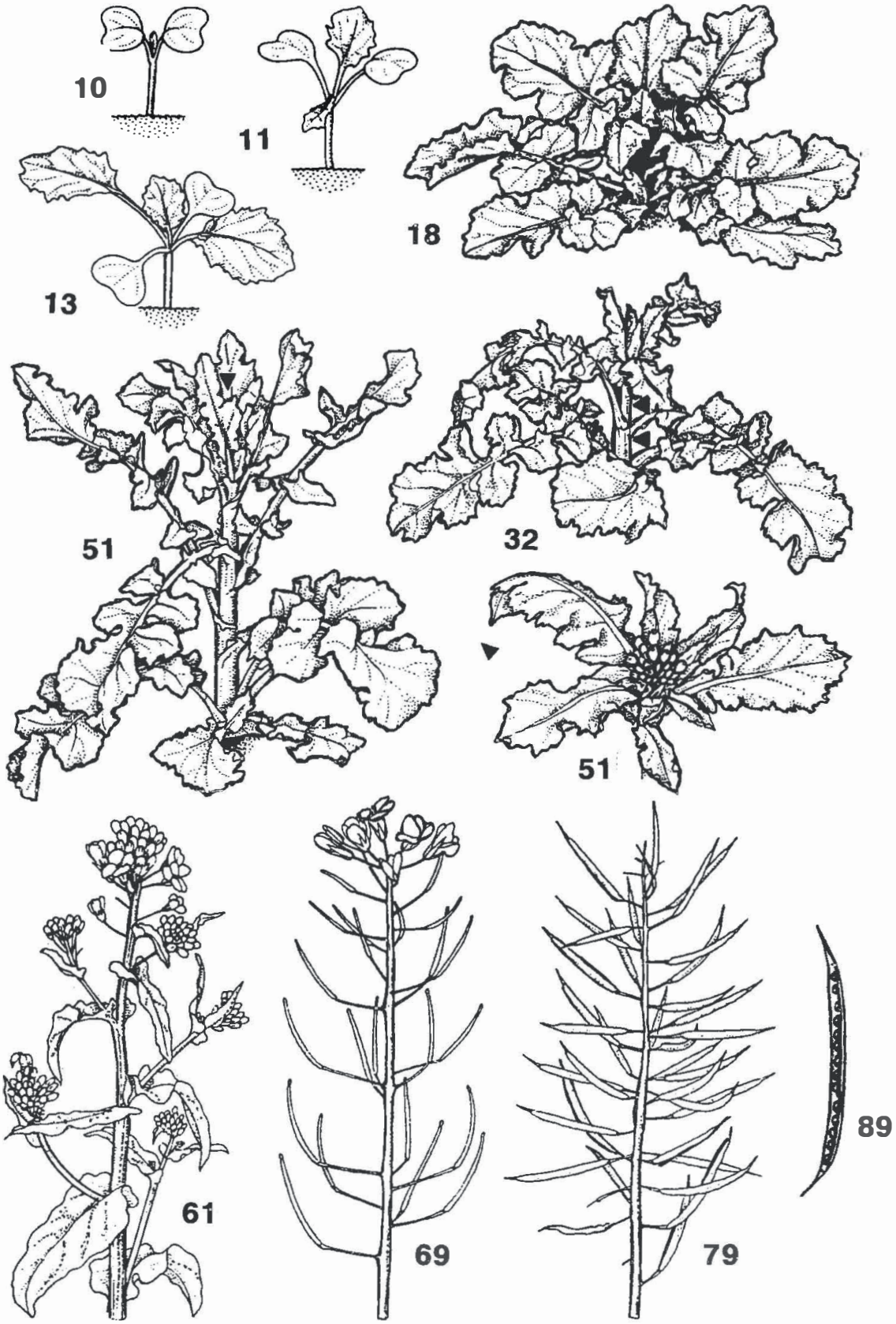
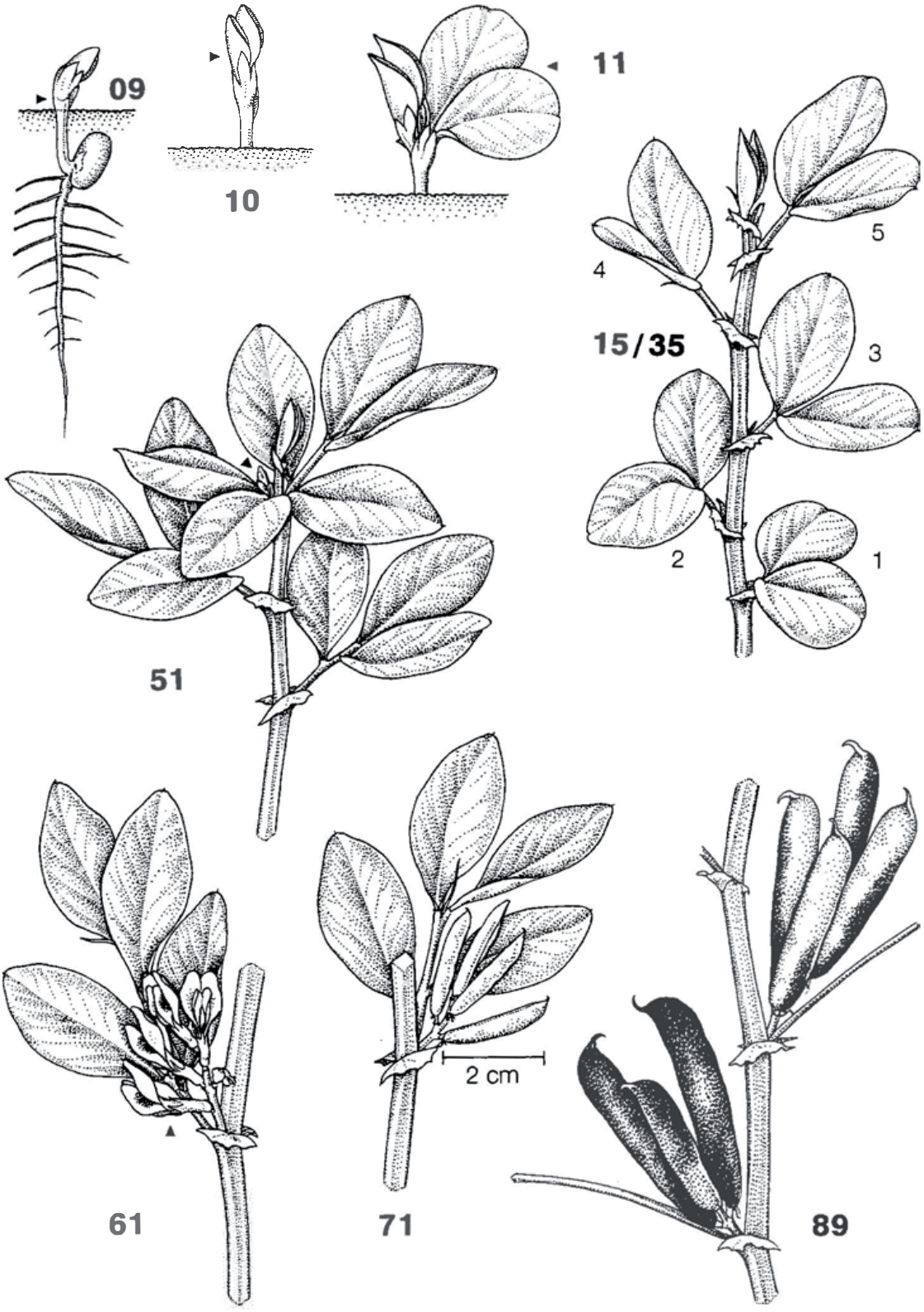
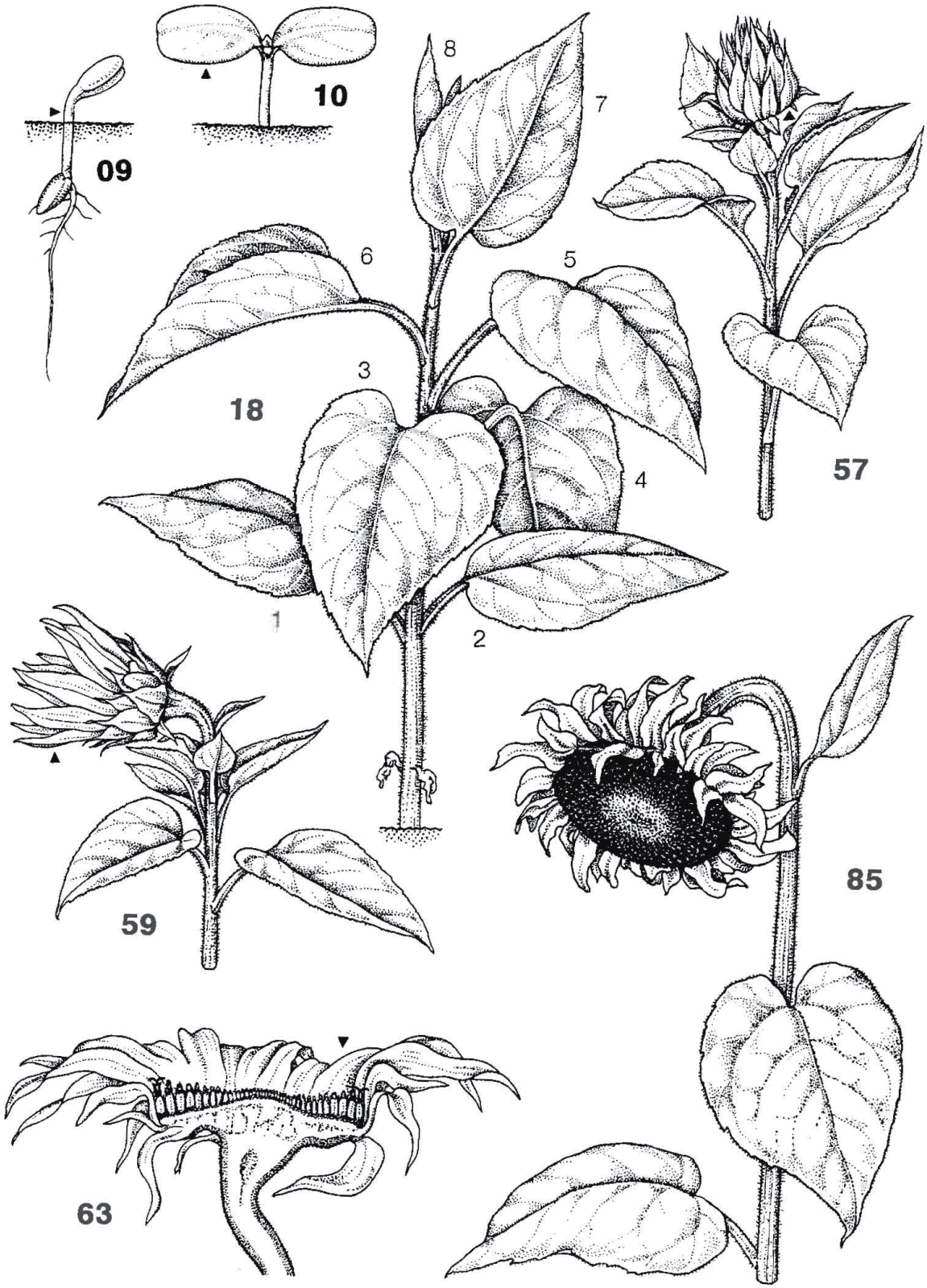


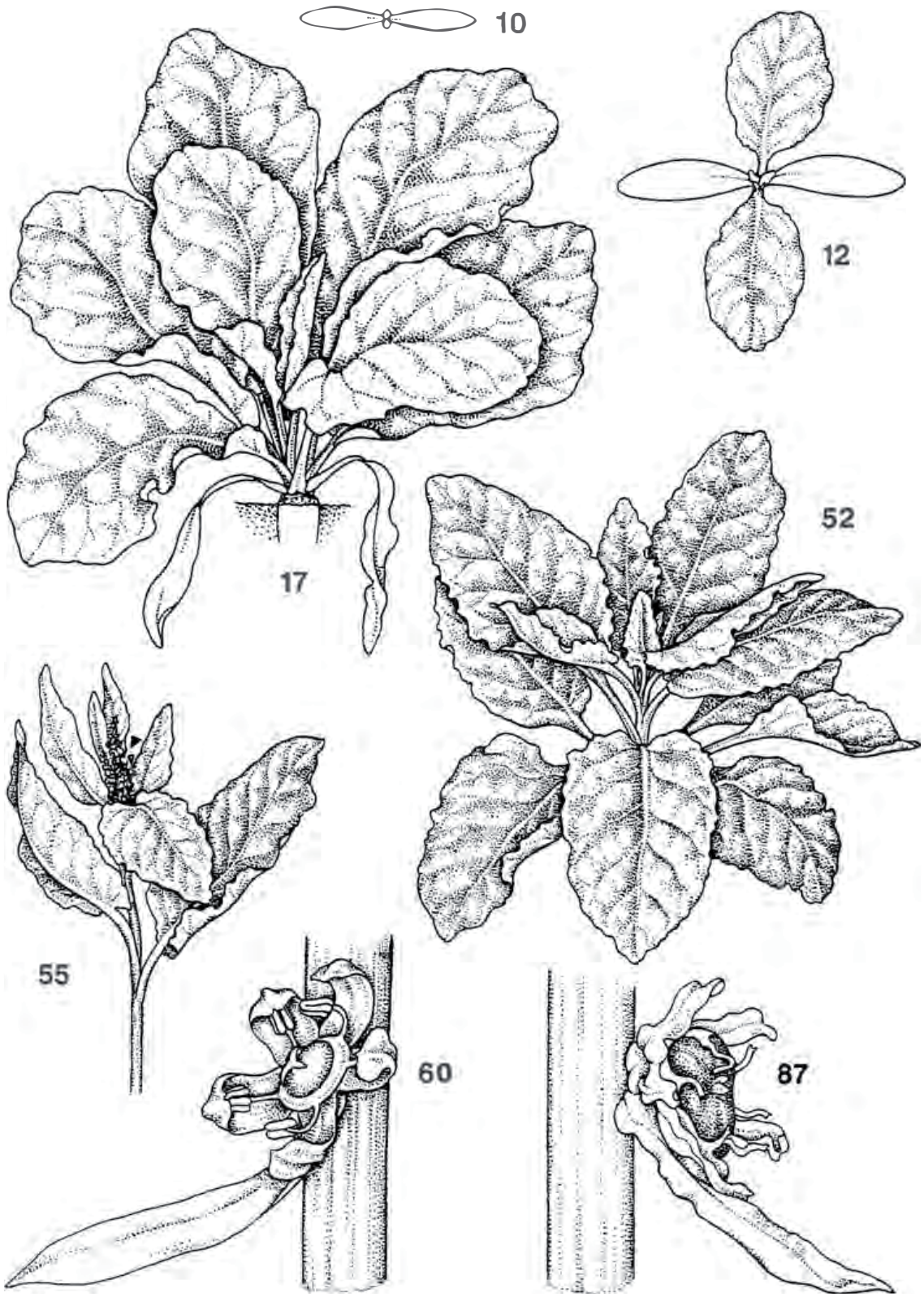
4 Rape • Raps • Colza / nabo • Colza



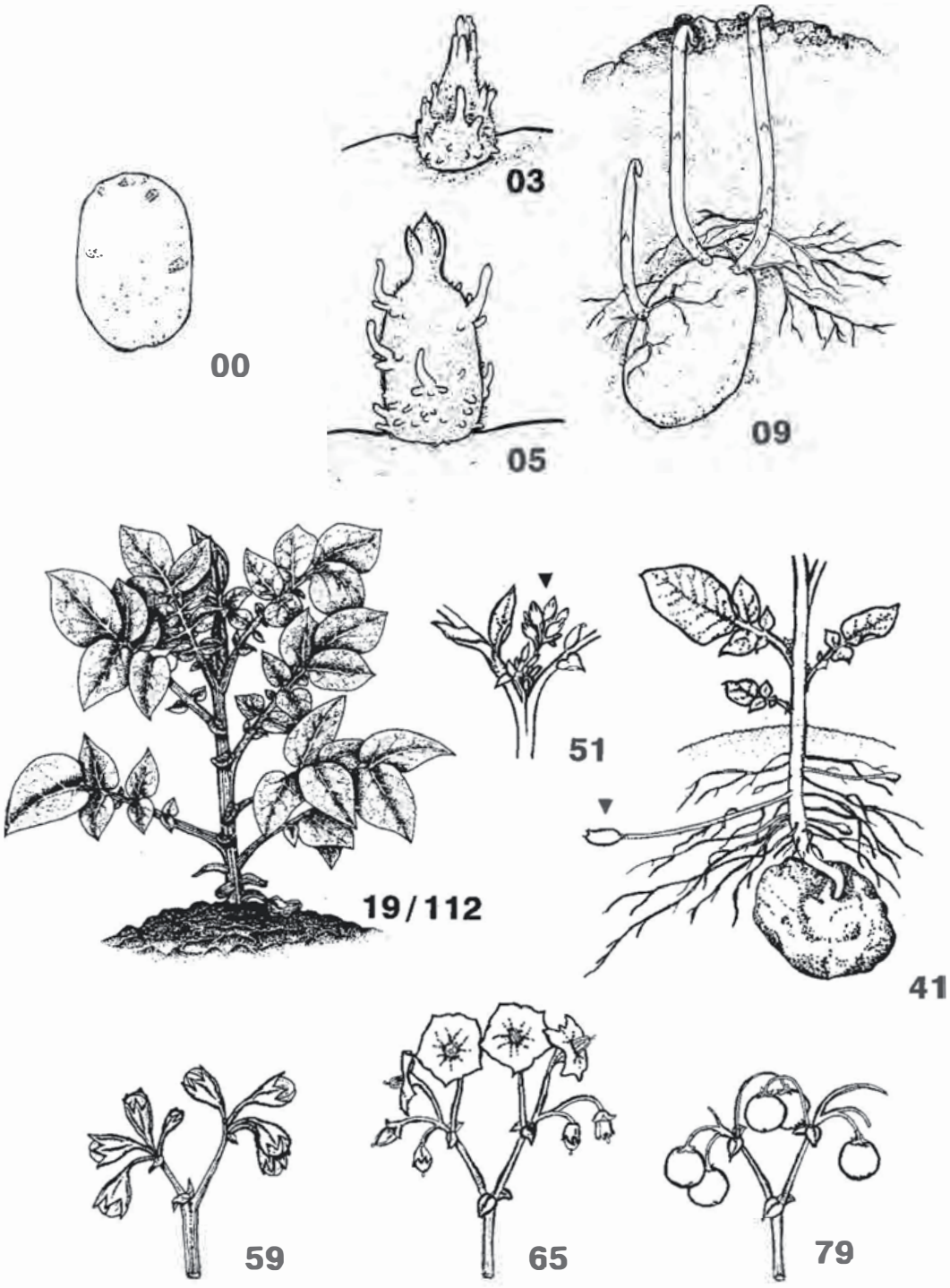
5 Faba bean • Faba-Bohne • Haba común • Féverole



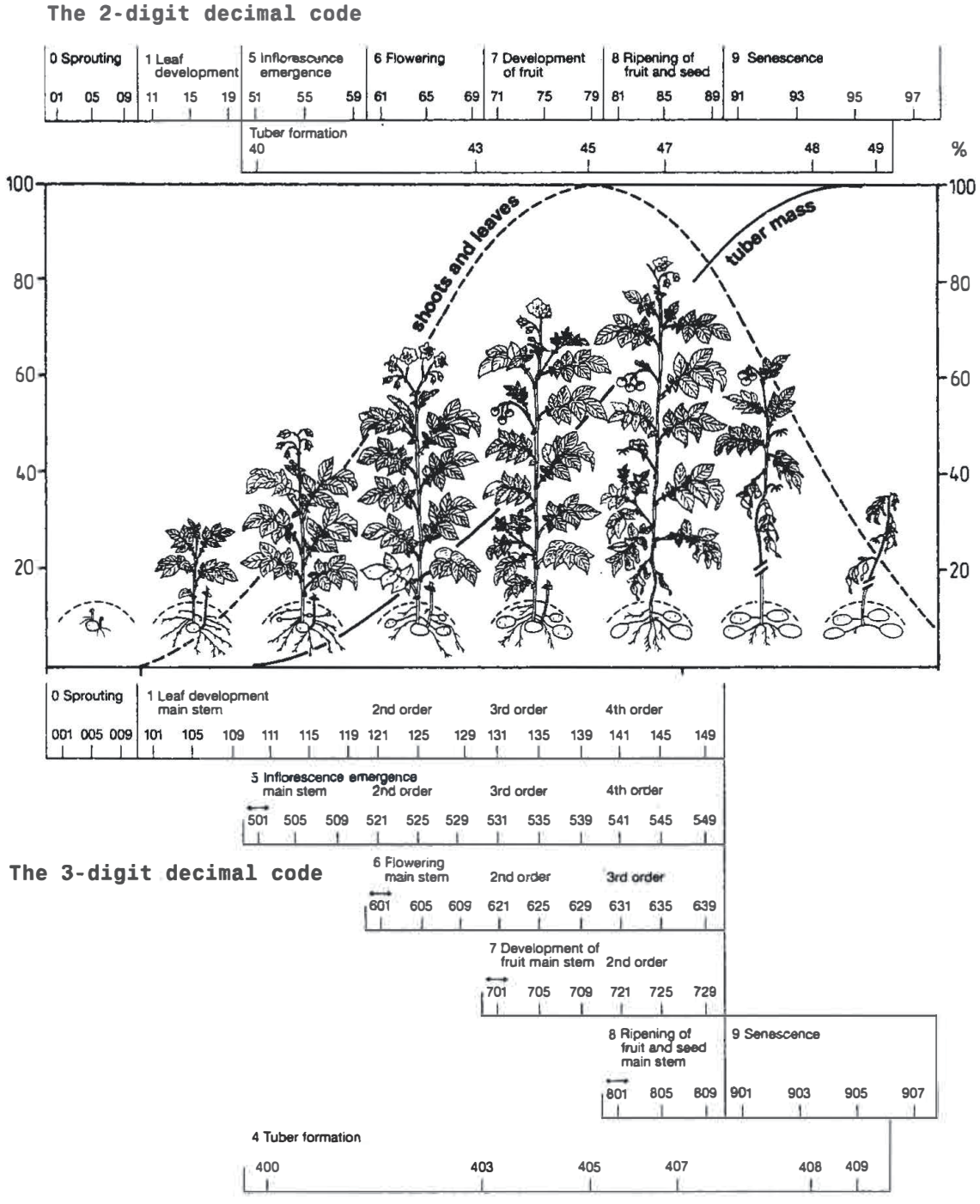
6 Sunflower • Sonnenblume • Girasol • Tournesol



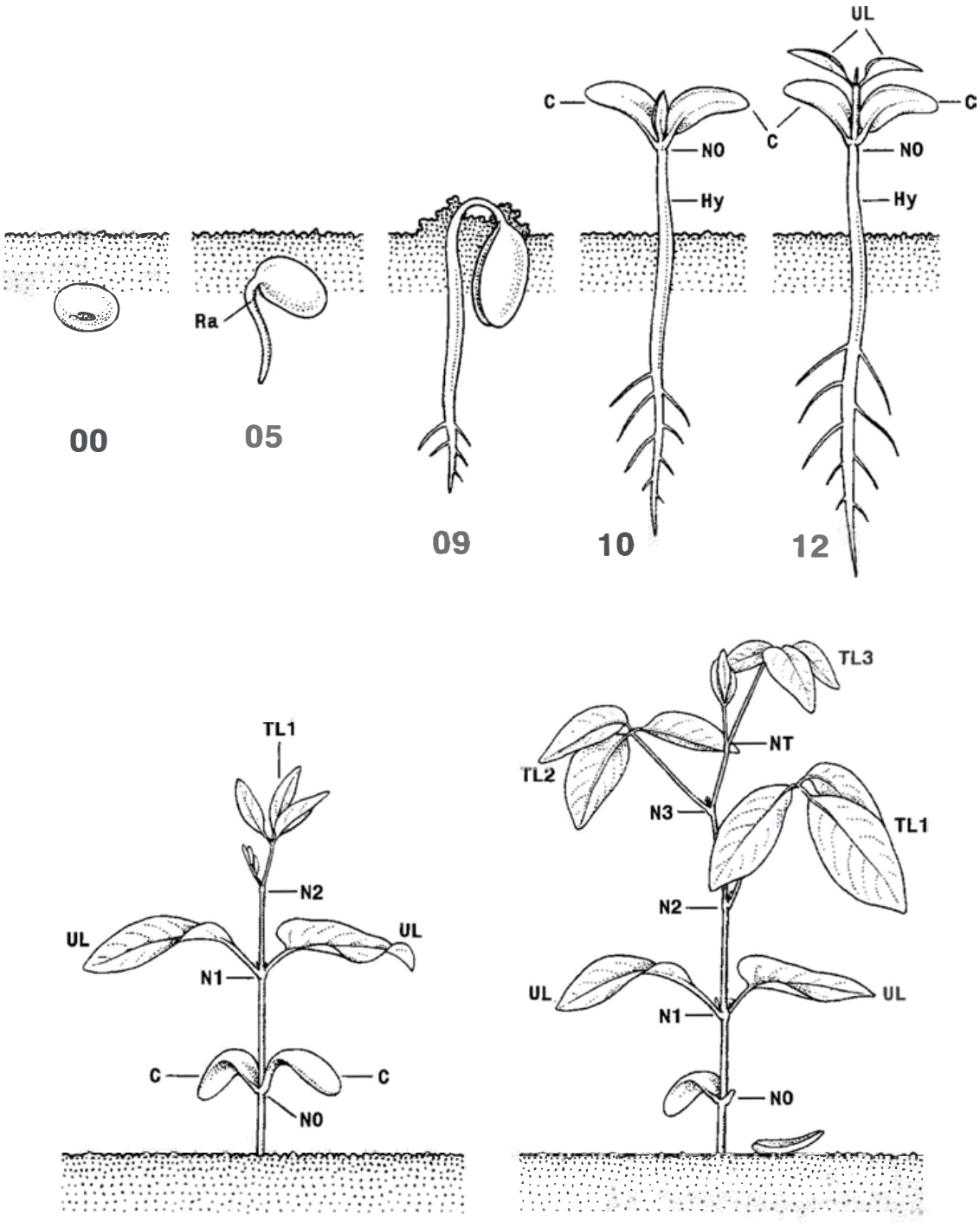
7 Beta beets • Beta-Rübe • Remolacha • Betterave



8 Potato • Kartoffel • Patata / papa • Pomme de terre



8 Growth stages of potato, Hack et al., 1993



9 Soybean • Sojabohne • Soja • Soja

Soybean • Sojabohne • Soja • Soja

Legend			Legende
Ra	=	Radicle	Keimwurzel
Hy	=	Hypocotyl	Hypocotyl
Co	=	Cotyledons	Keimblätter
N0	=	Cotyledonary node (node 0)	Keimblattknoten (Knoten 0)
N1	=	1st node	1. Nodium
UL	=	unifoliate leaf	ungeteiltes Laubblatt
N2	=	2nd node	2. Nodium
TL1	=	1st trifoliate leaf	1. dreigeteiltes Laubblatt
Nn	=	nth node	n-tes Nodium
TLn	=	nth trifoliate leaf	n-tes dreigeteiltes Laubblatt
NT	=	terminal node	letzter Knoten
N3	=	3rd node	3. Knoten
TL2	=	2nd trifoliate leaf	2. dreigeteiltes Laubblatt
S1	=	1st side shoot	1. Seitensproß
Sn	=	nth side shoot	n-ter Seitensproß
iF	=	Inflorenscence bud	Infloreszenzknospe
Fo	=	Flower (open)	Blüte (offen)
Pb	=	Pods (15–20 mm)	Hülsen (15–20 mm)
Pd	=	Pod (full sized)	Hülse (endgültige Größe)
Kb	=	Seed (approx. 3 mm)	Samen (etwa 3 mm)
Kd	=	Seed (full sized)	Samen (endgültige Größe)
Pm	=	Pod (mature)	Hülse (reif)
Km	=	Seed (mature)	Samen (reif)

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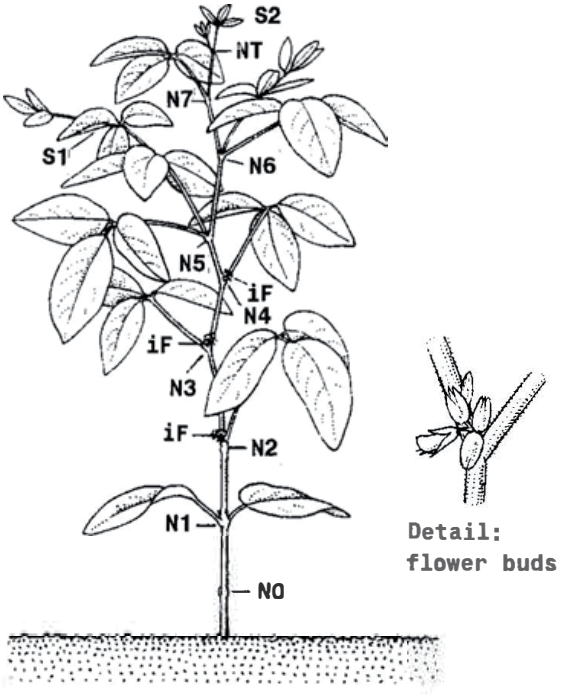

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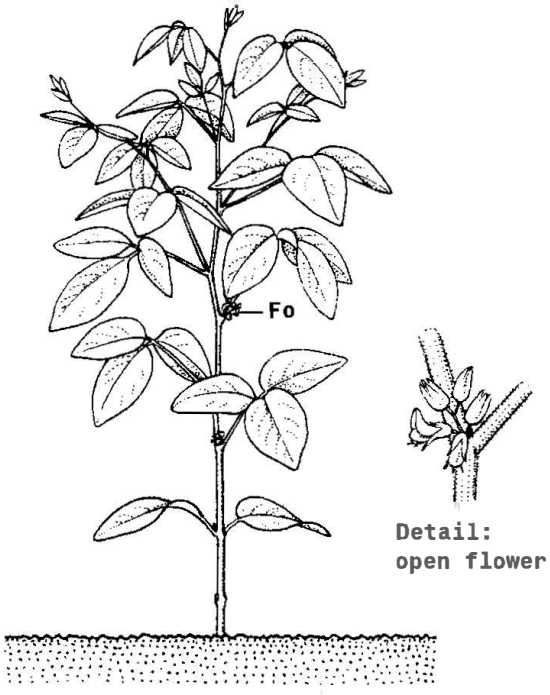

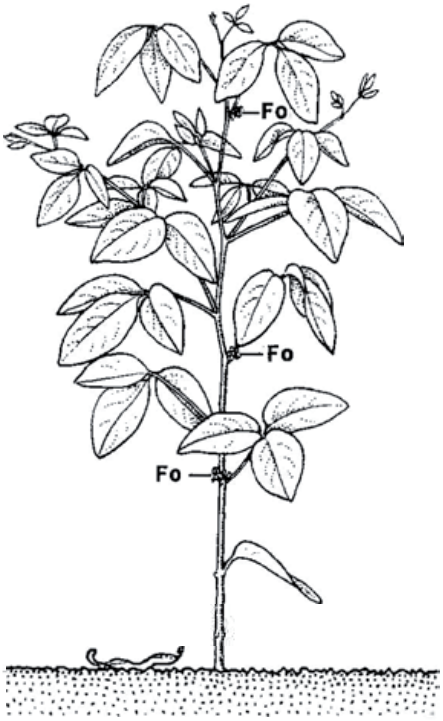

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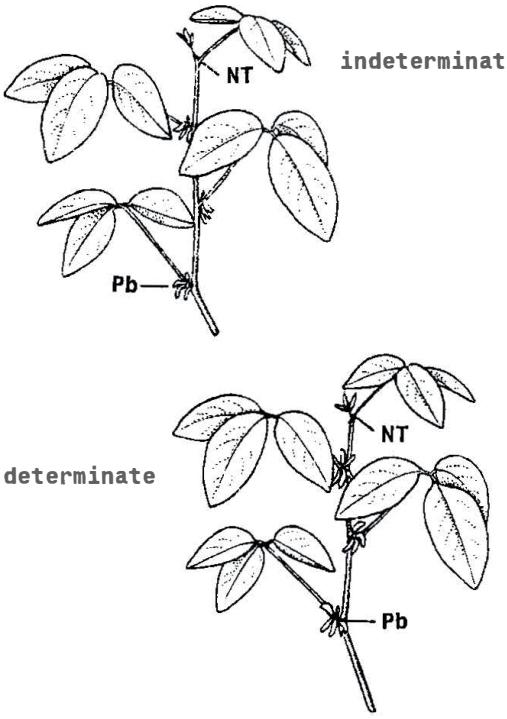

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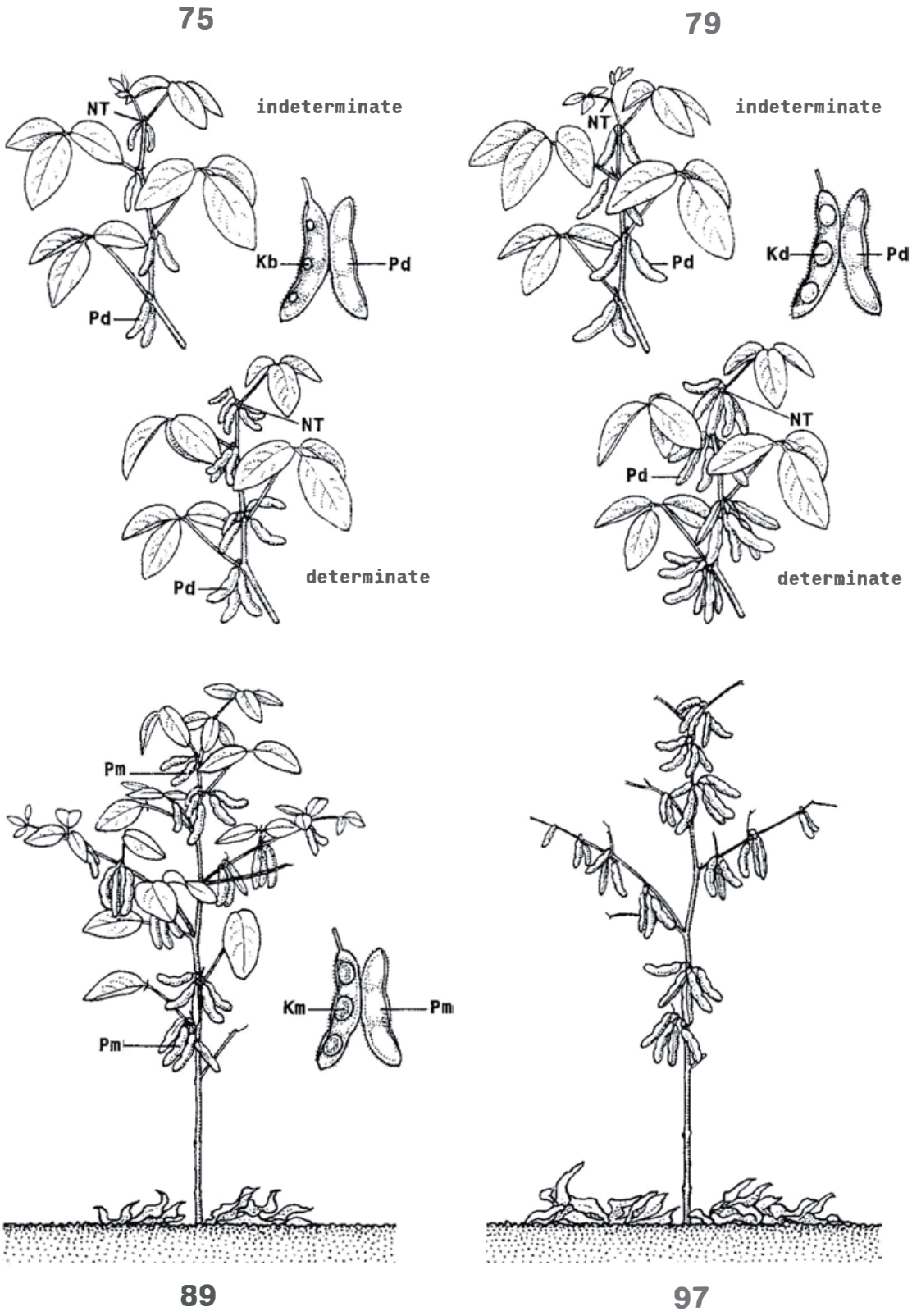
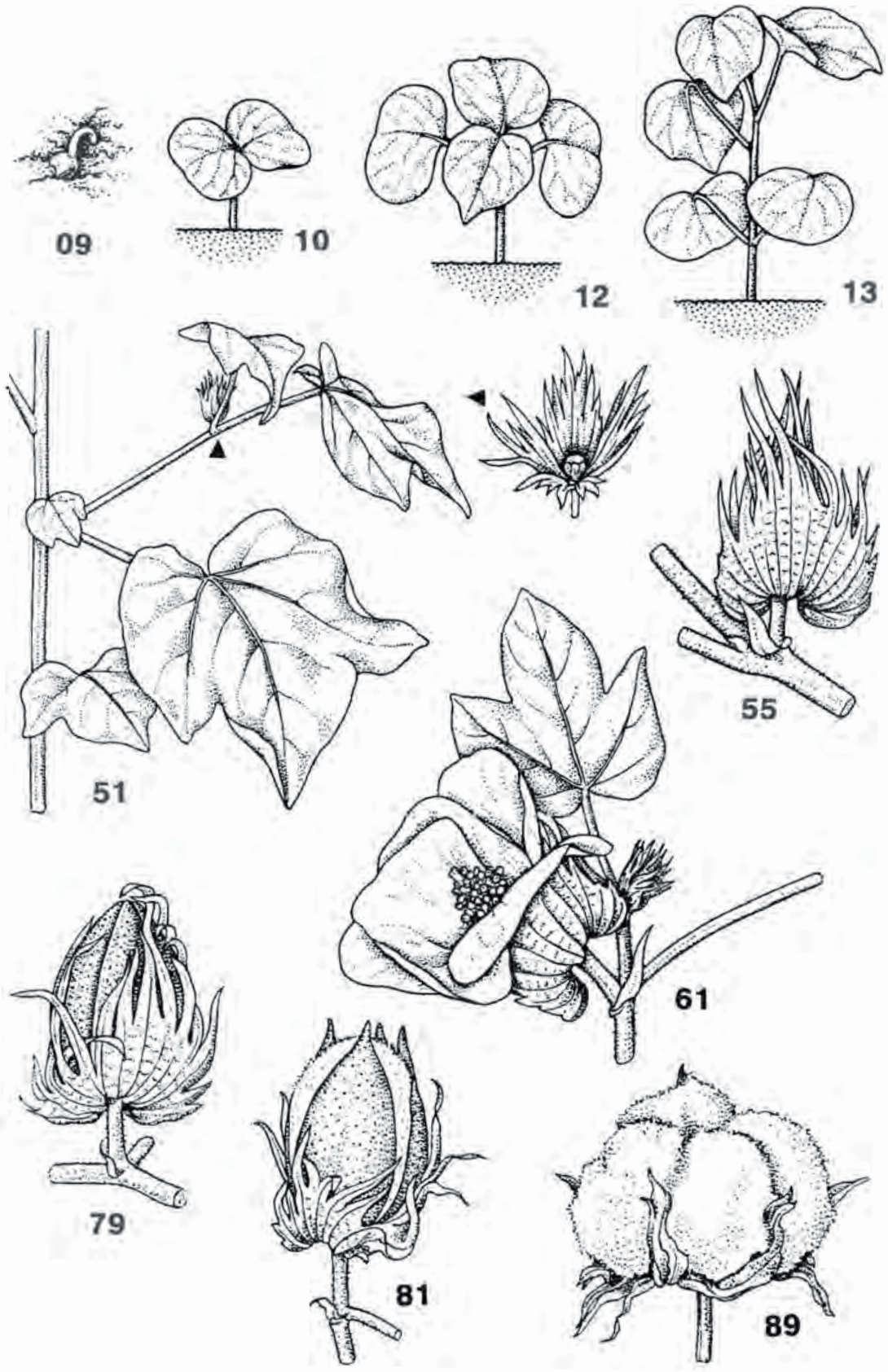
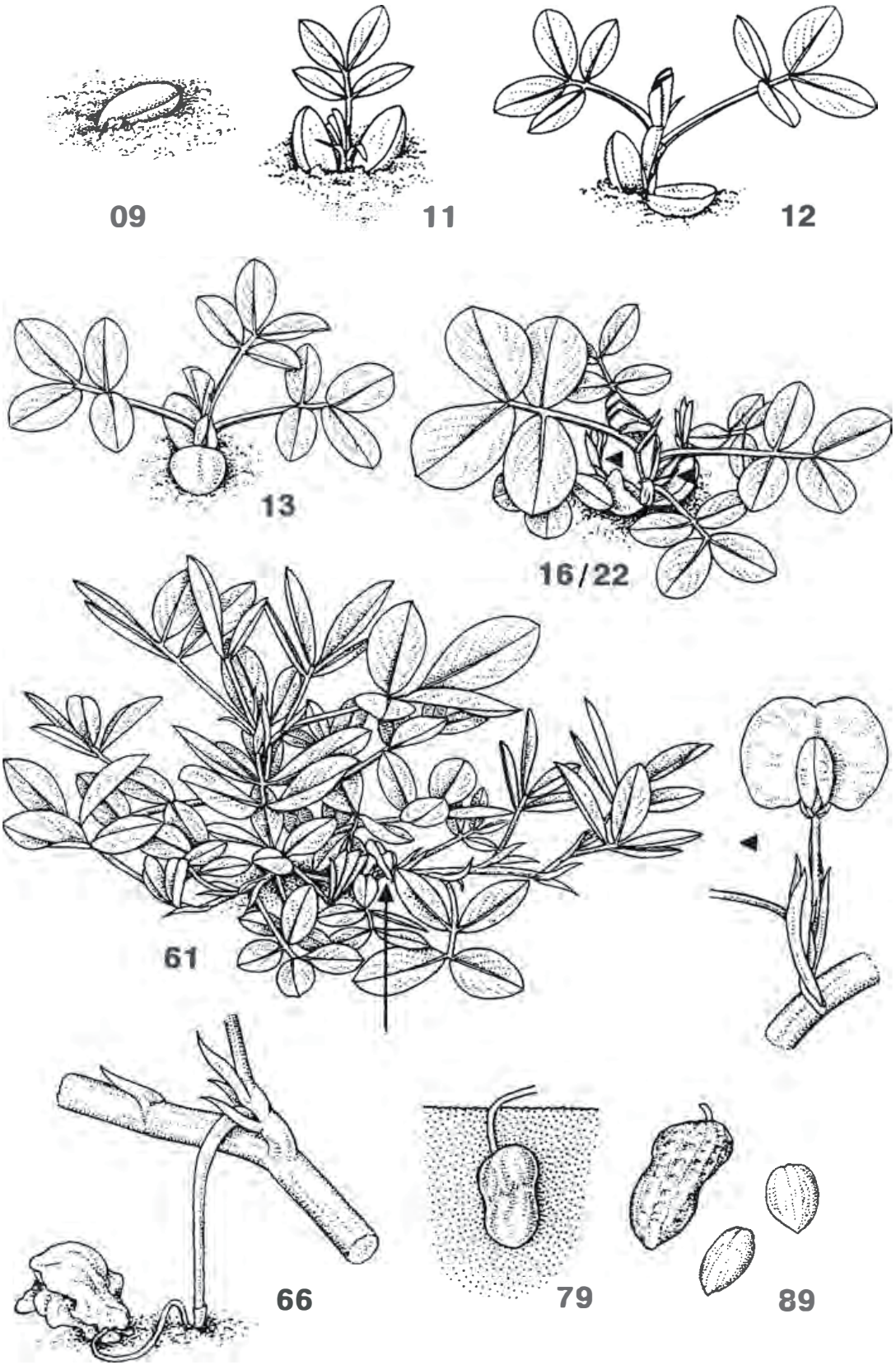


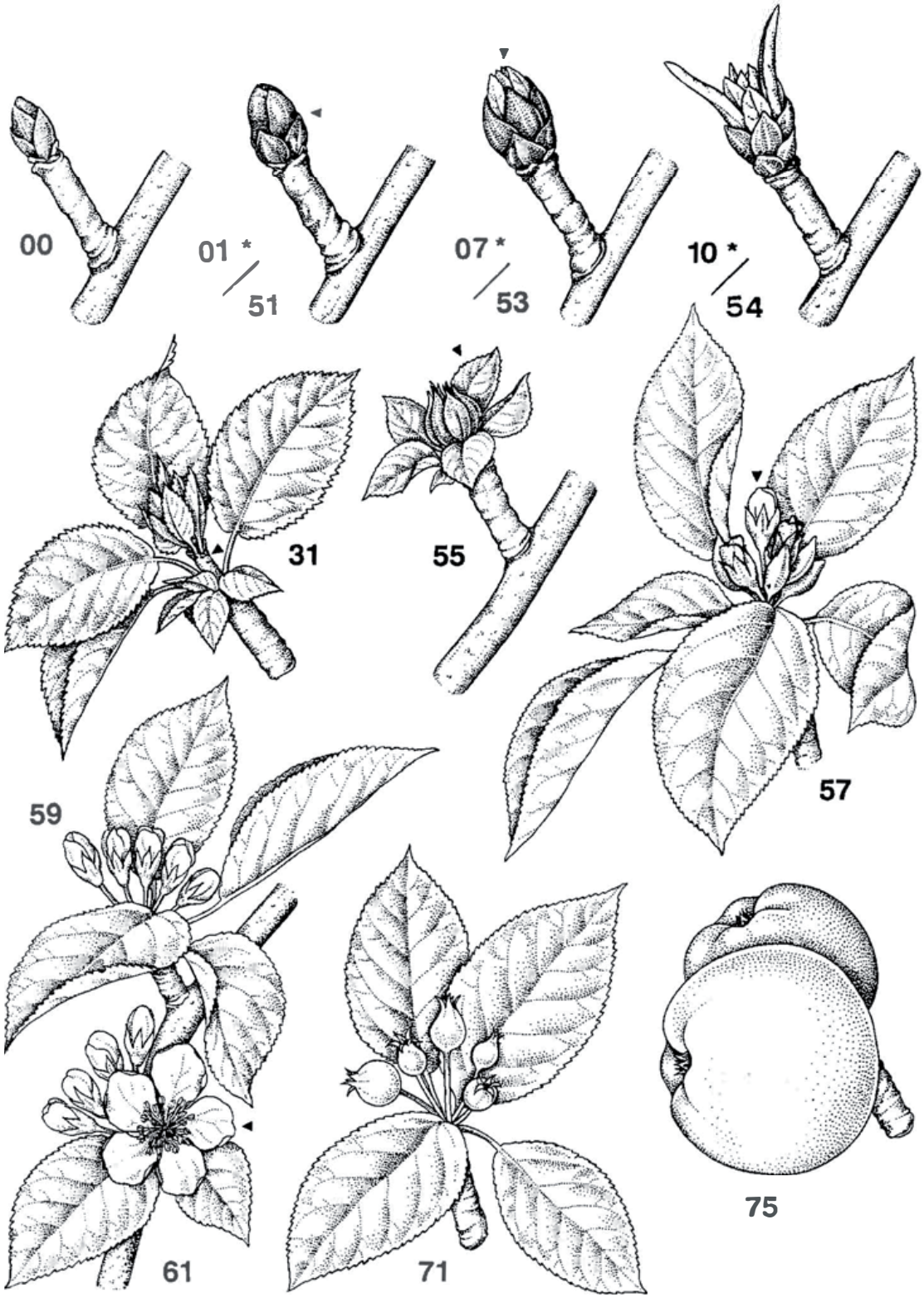
9 Soybean • Sojabohne • Soja • Soja



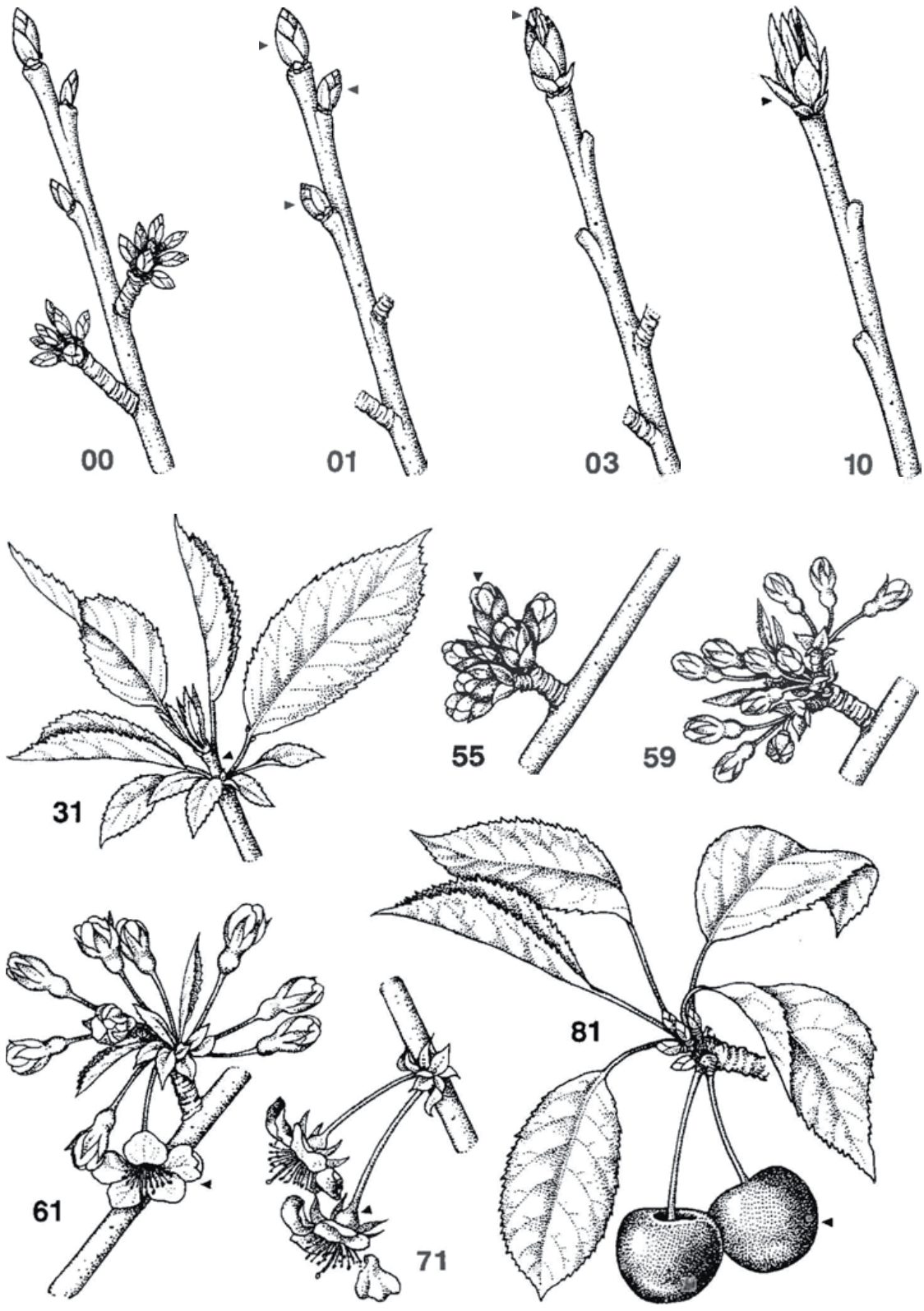
10 Cotton • Baumwolle • Algodón • Coton



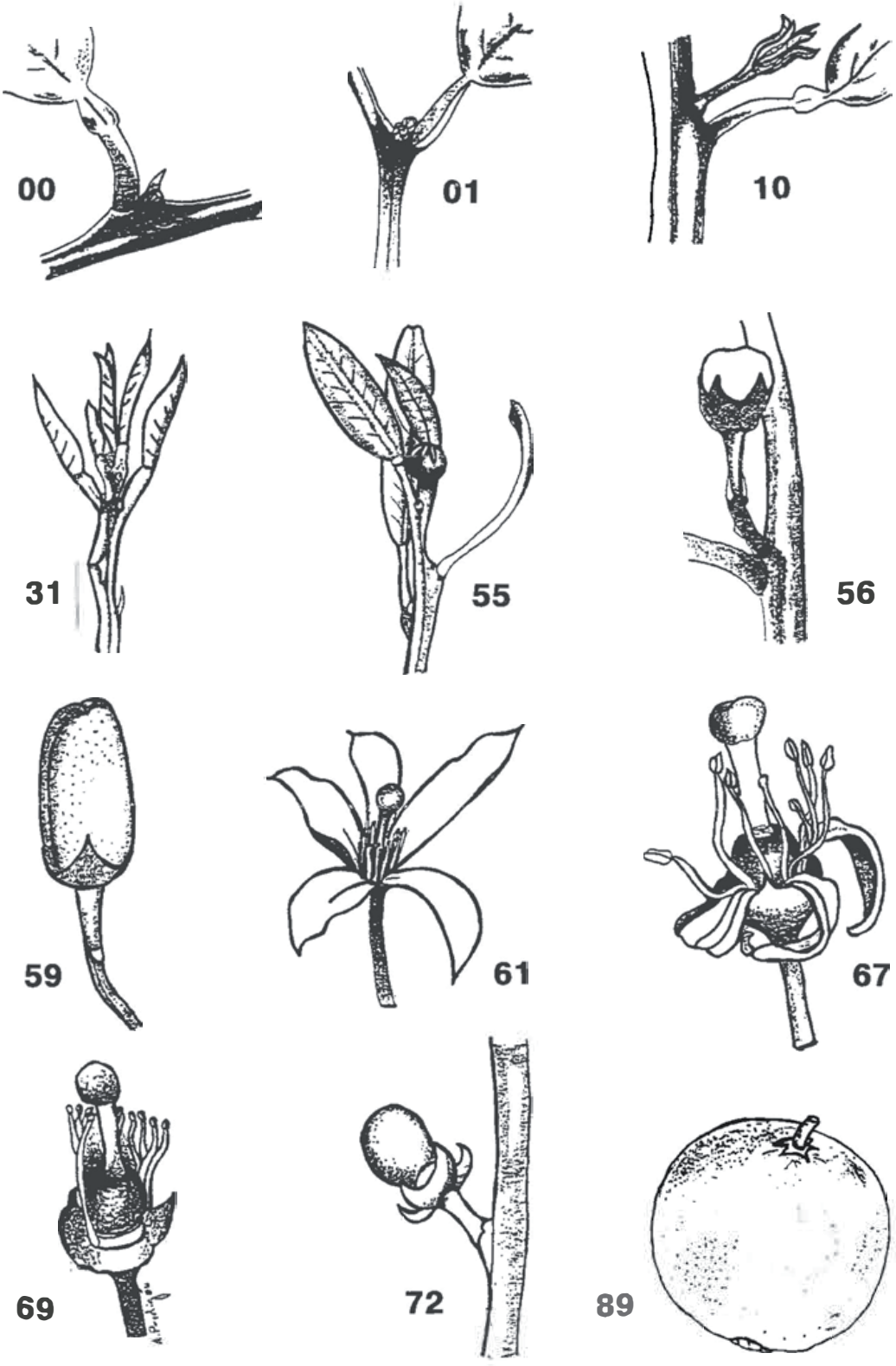
11 Peanut • Erdnuß • Maní / Cacahuete • Cacahuète



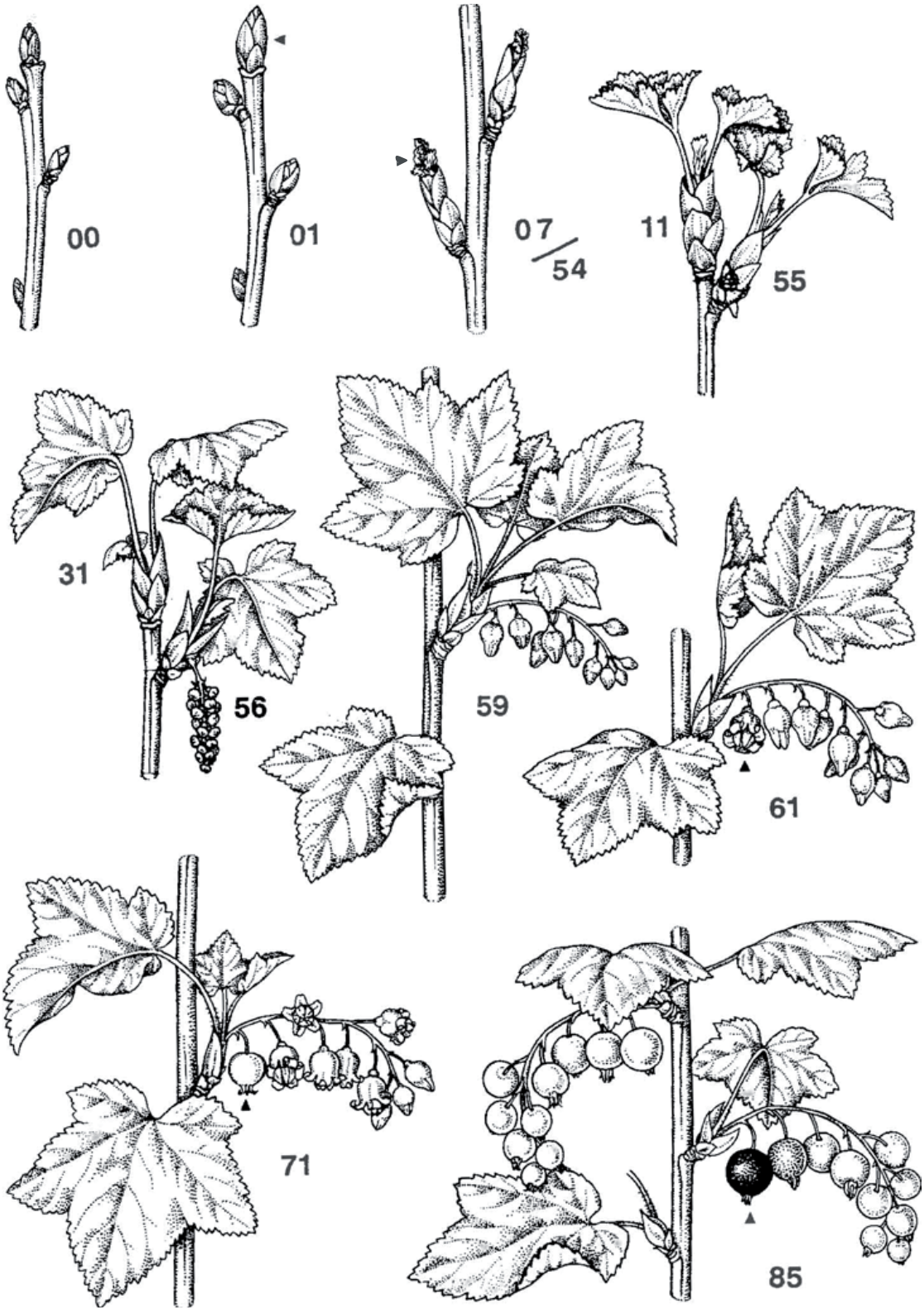
12 Pome fruit • Kernobst • Frutales de pepita • Fruits à pépins



13 Stone fruit • Steinobst • Frutales de hueso • Fruits à noyaux

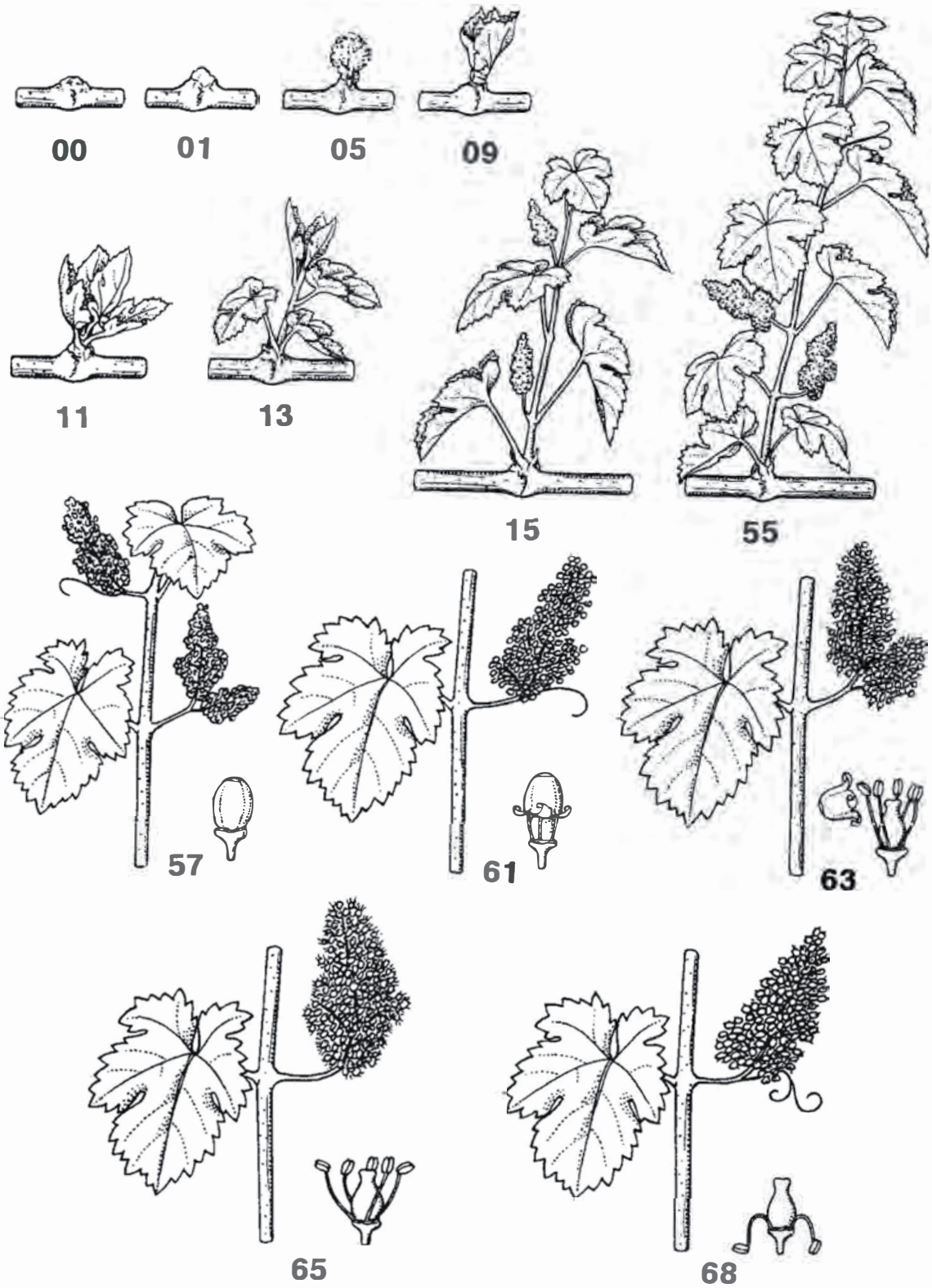


14 Citrus • Citrus • Agrios • Argumes

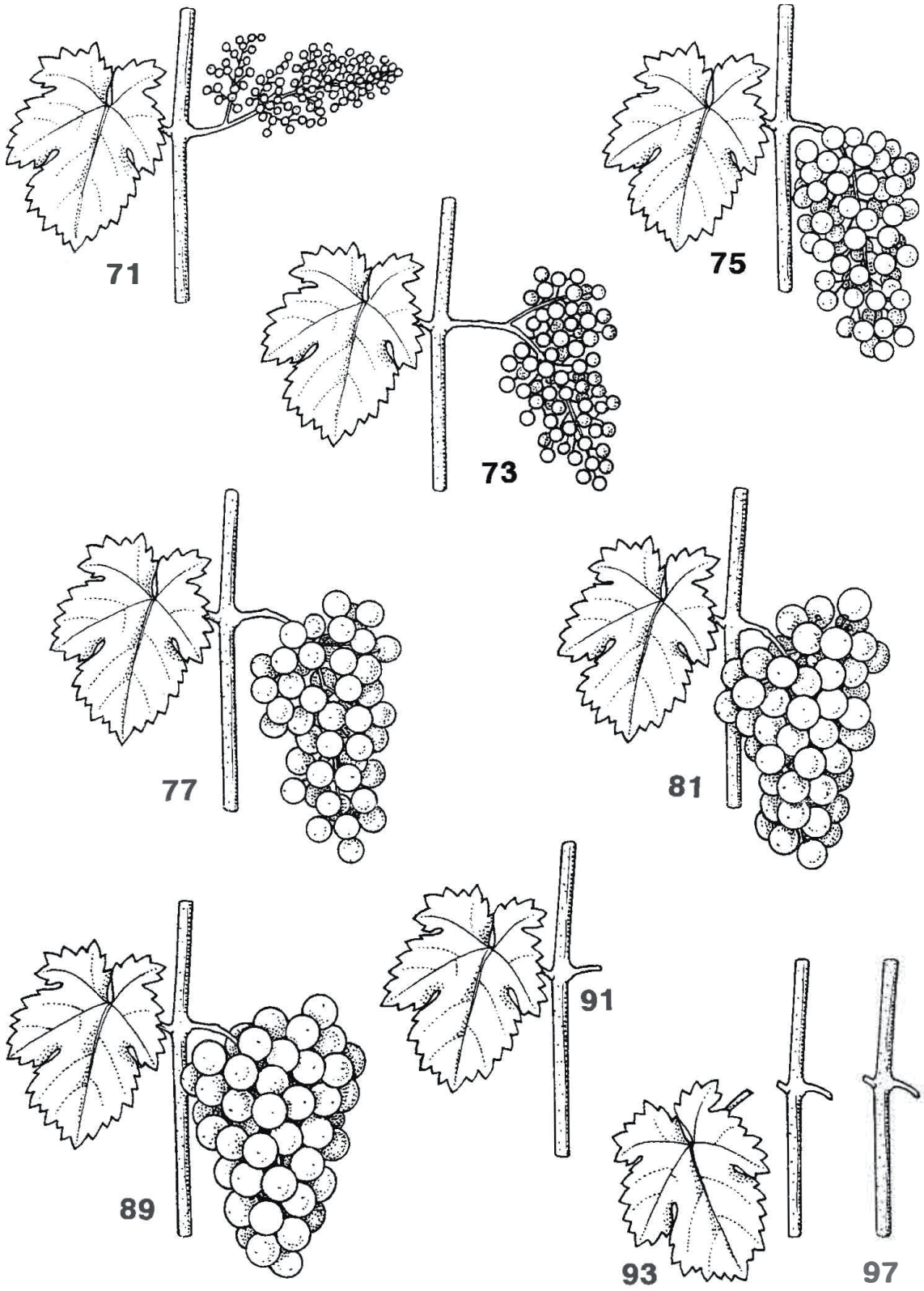


15 Currants • Johannisbeere • Grosellero • Groseilleir

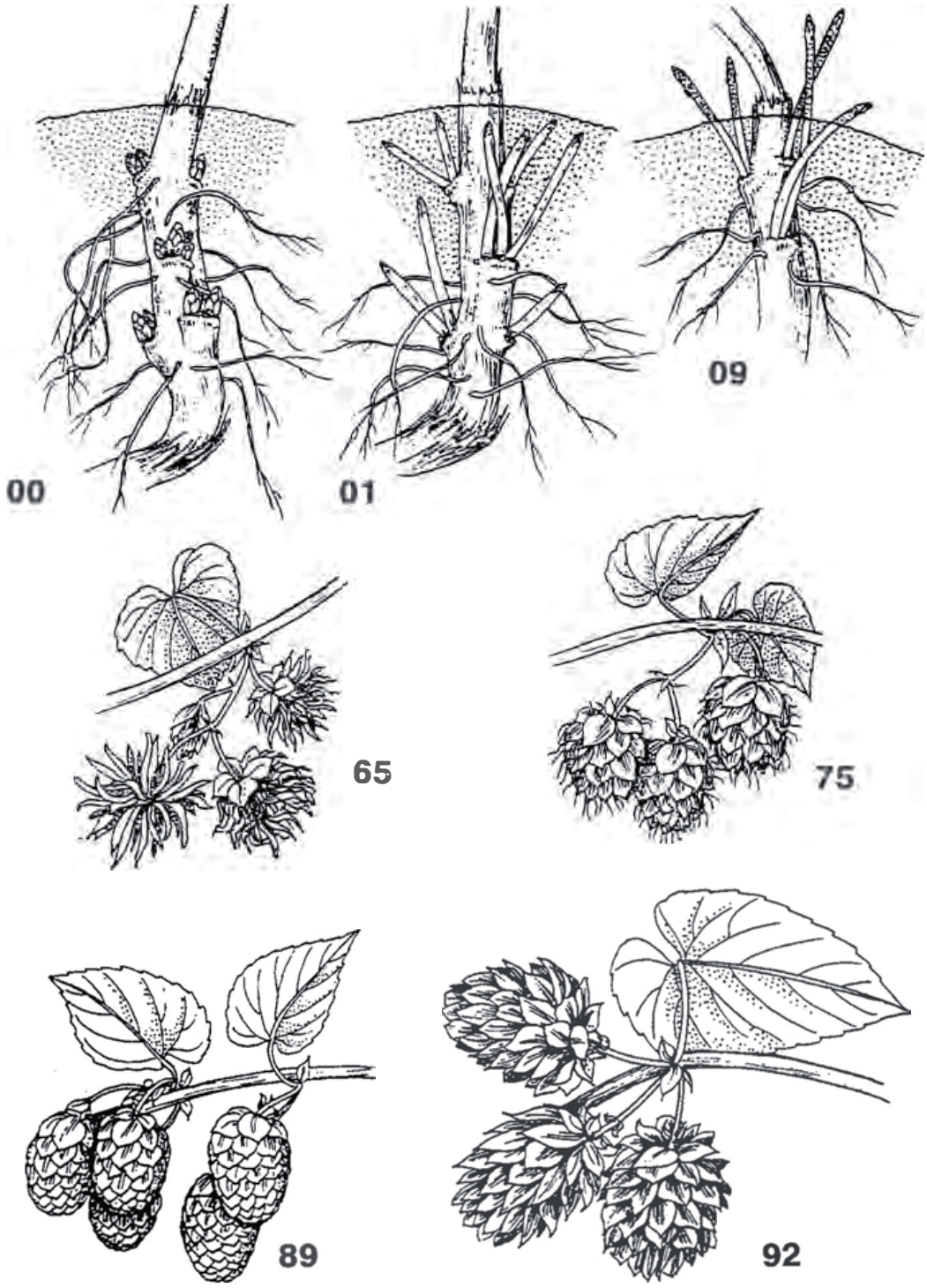
16 Strawberry • Erdbeere • Fresa • Fraise



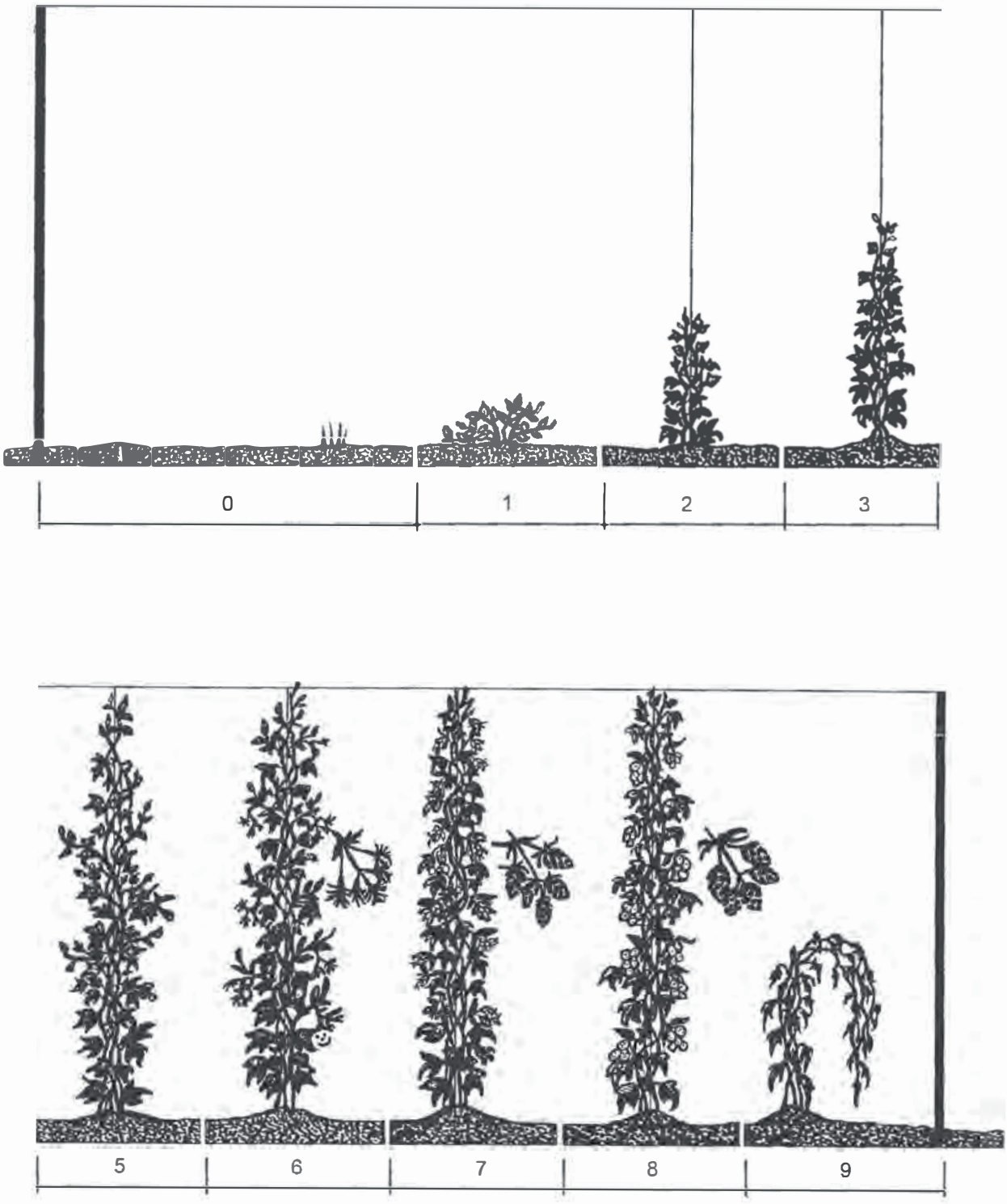
17 Grapevine • Weinrebe • Vid • Vigne



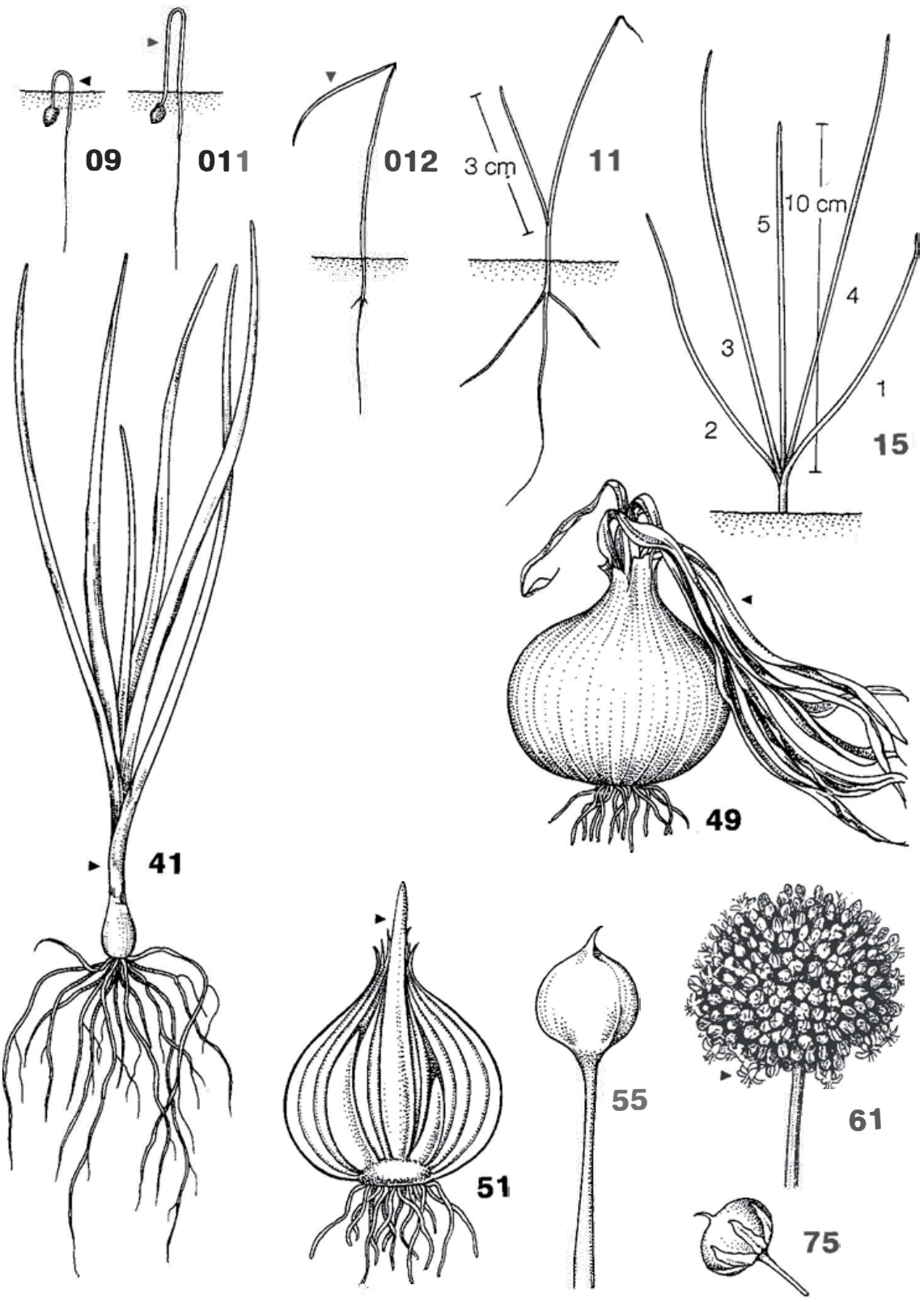
17 Grapevine • Weinrebe • Vid • Vigne



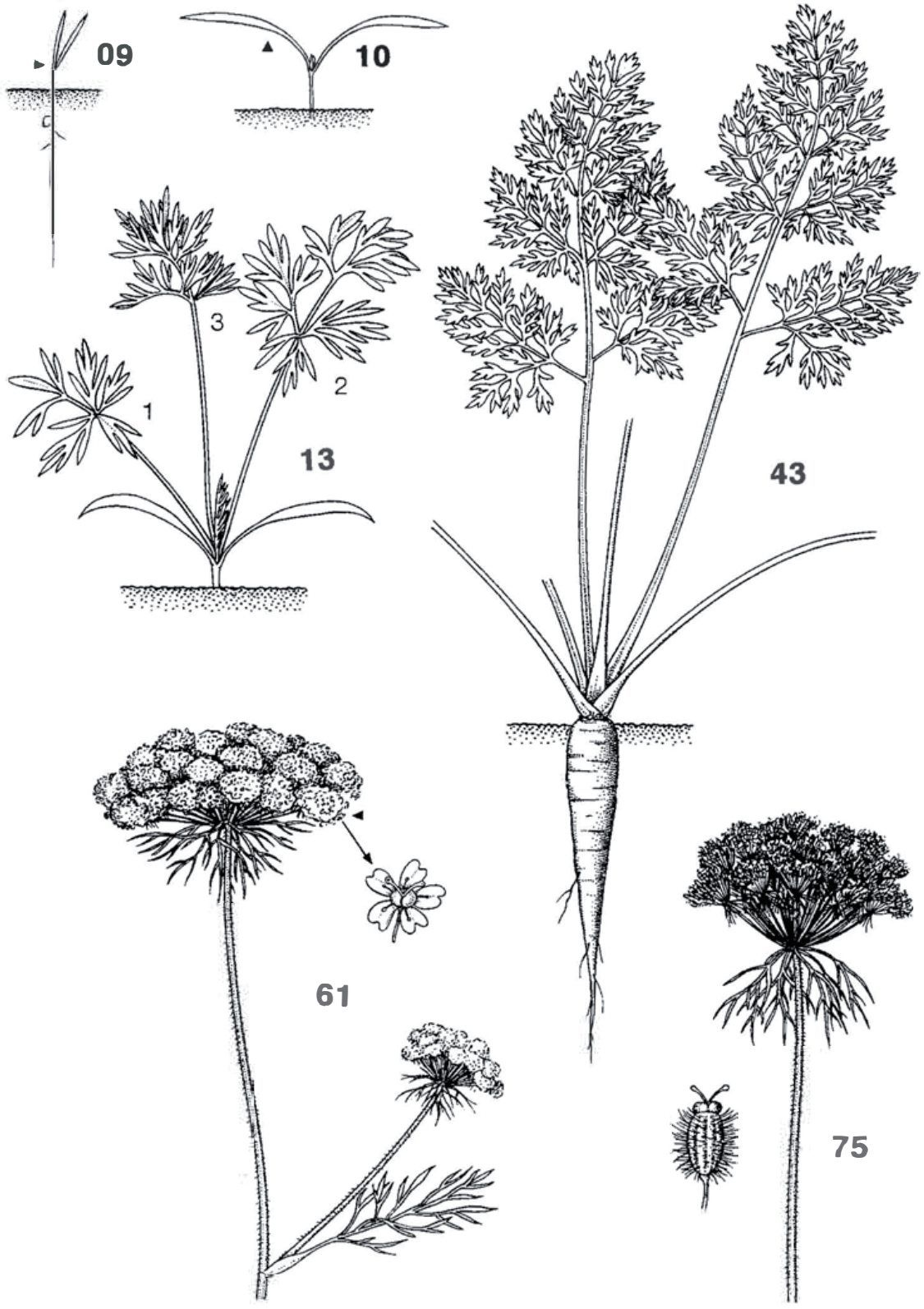
18 Hop • Hopfen • Lúpulo • Houblon



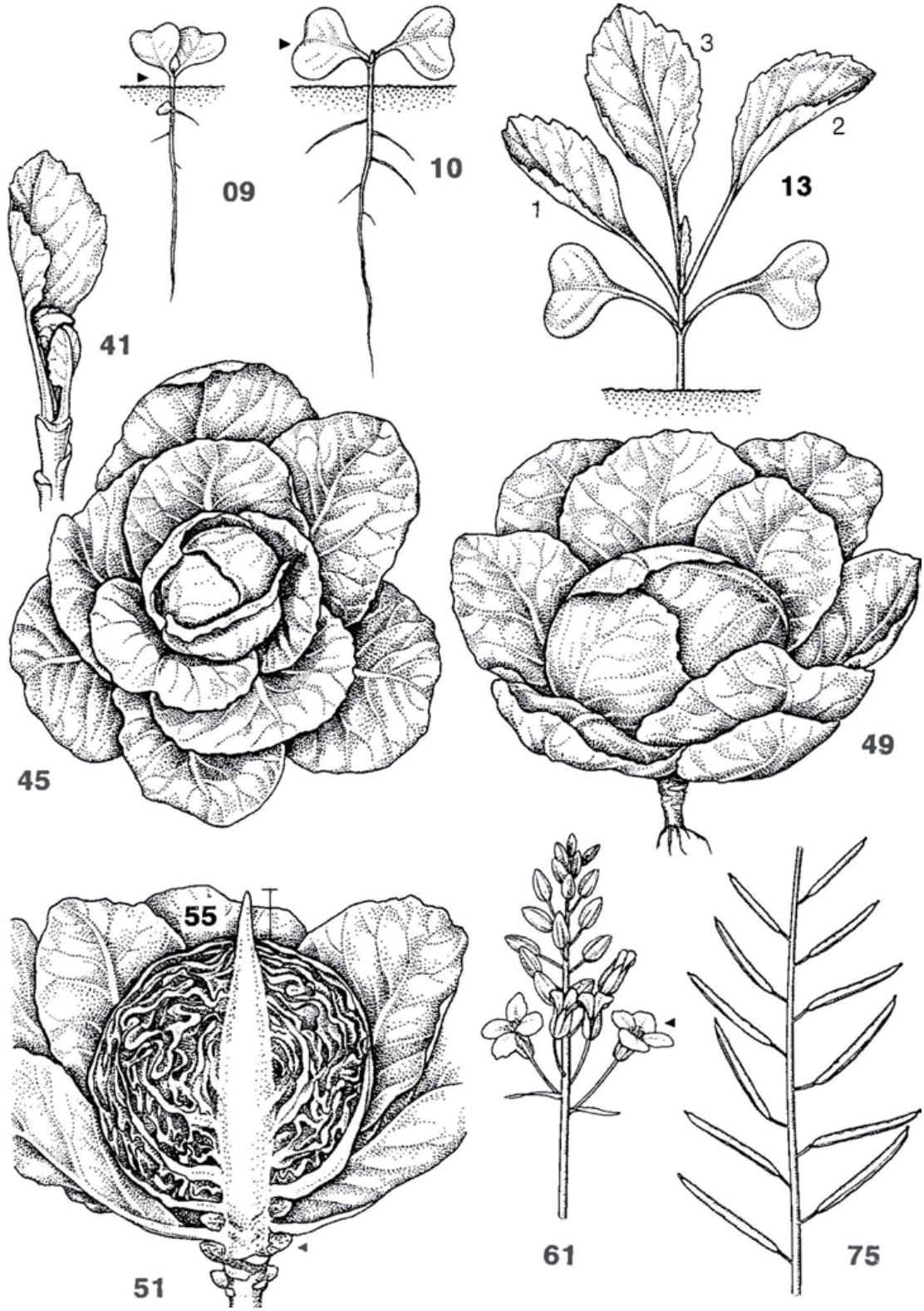
18 Hop • Hopfen • Lúpulo • Houblon



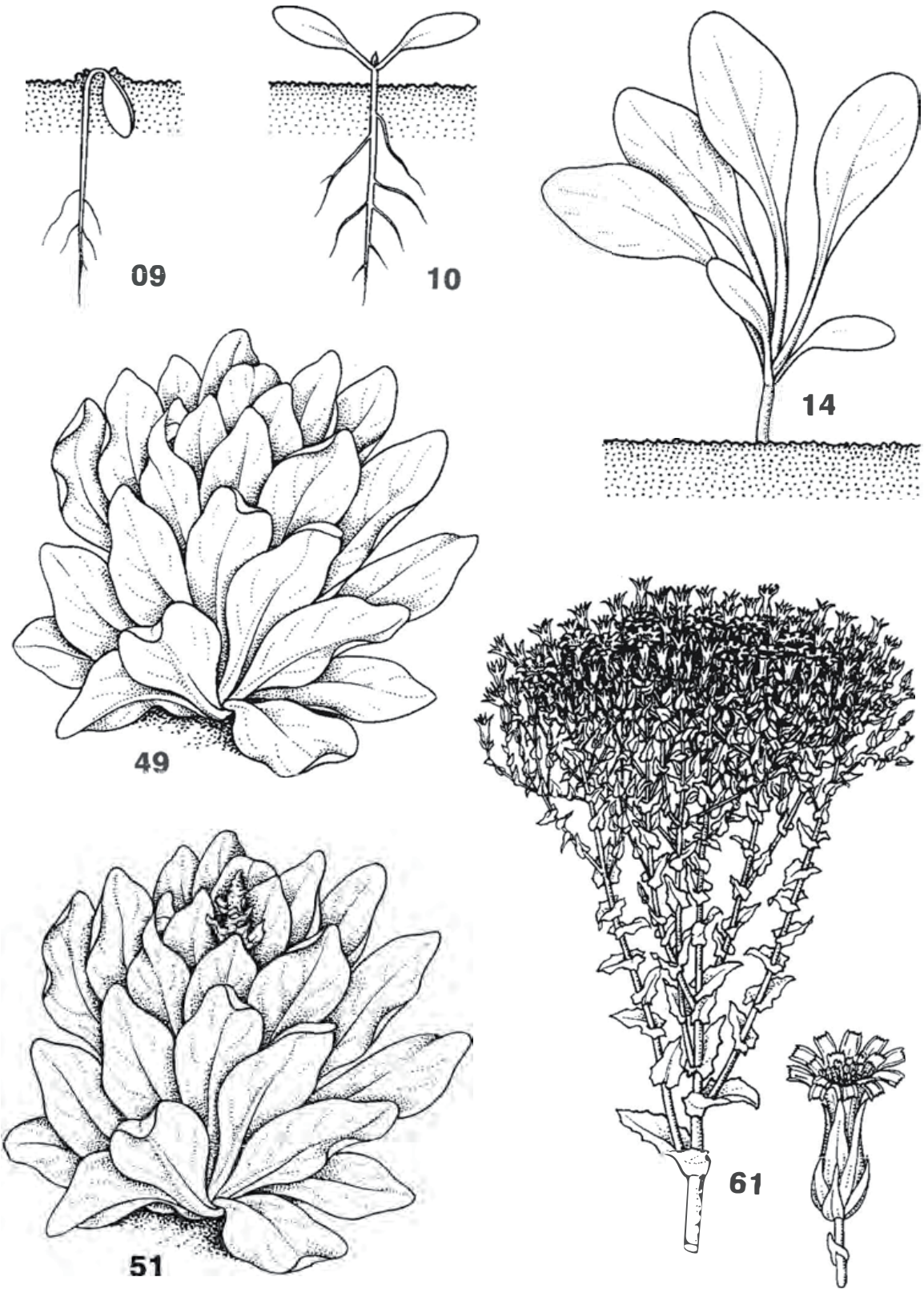
19 Bulb vegetables • Zwiebelgemüse • Hortalizas de plantas bulbosas • Espèces à bulbes



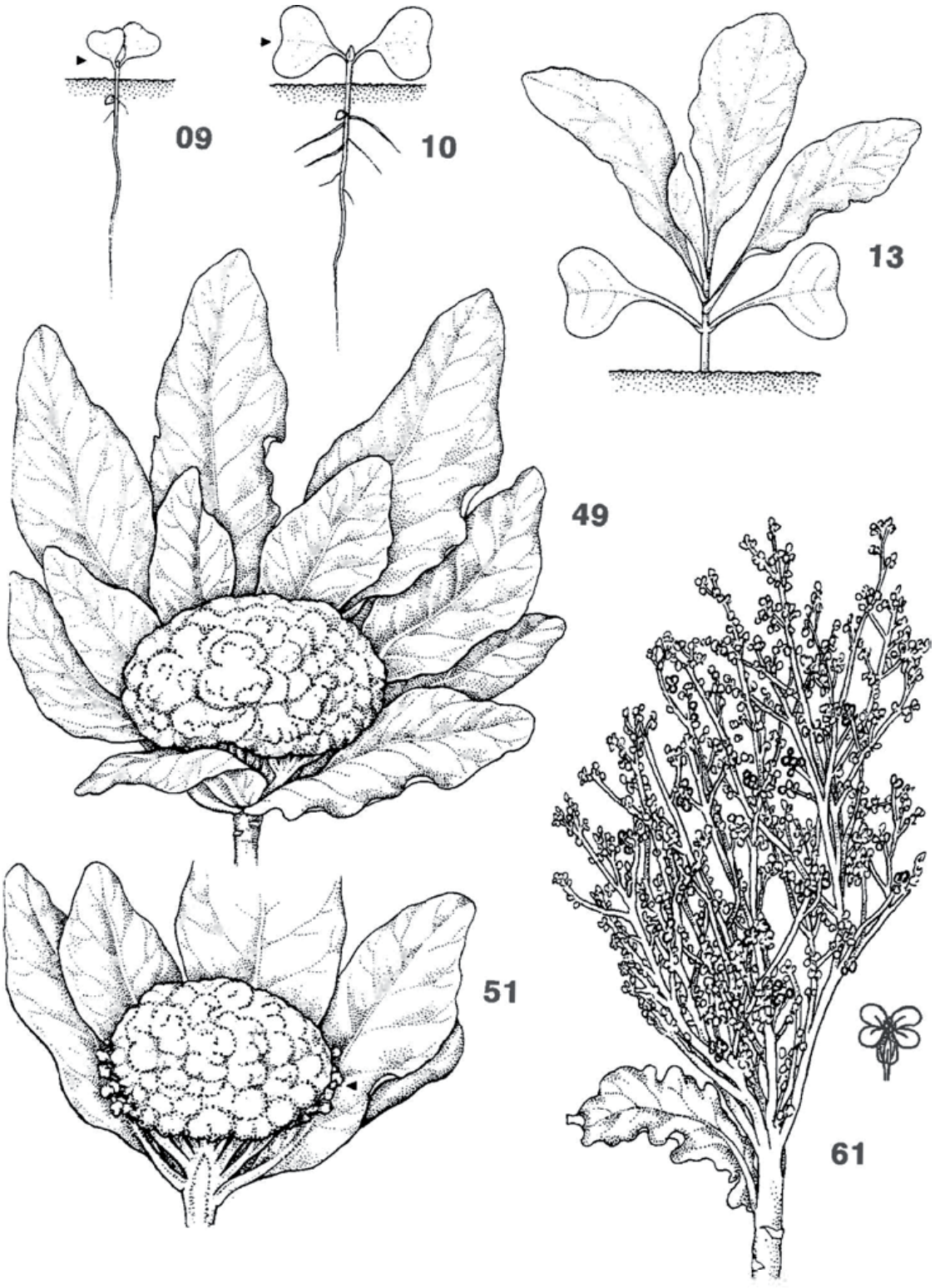
20 Root, tuber and stem vegetables • Wurzel- und Knollengemüse • Hortalizas de raiz y tubérculo • Espèces à racines ou tubercules



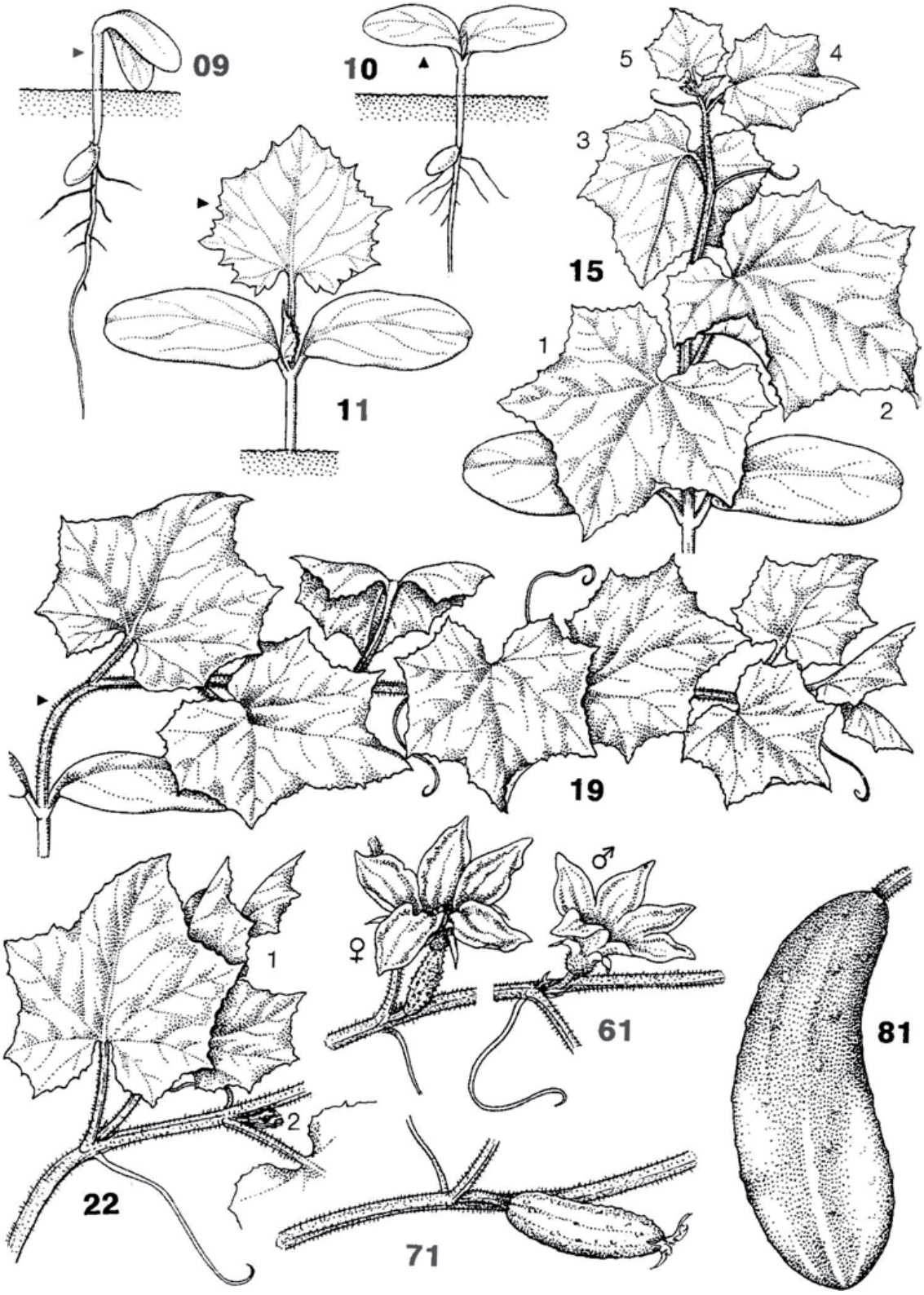
21 Leaf vegetables -forming heads- • Blattgemüse -kopfbildend- •
Verduras que forman cabeza • Légumes feuilles formant des „pommes“



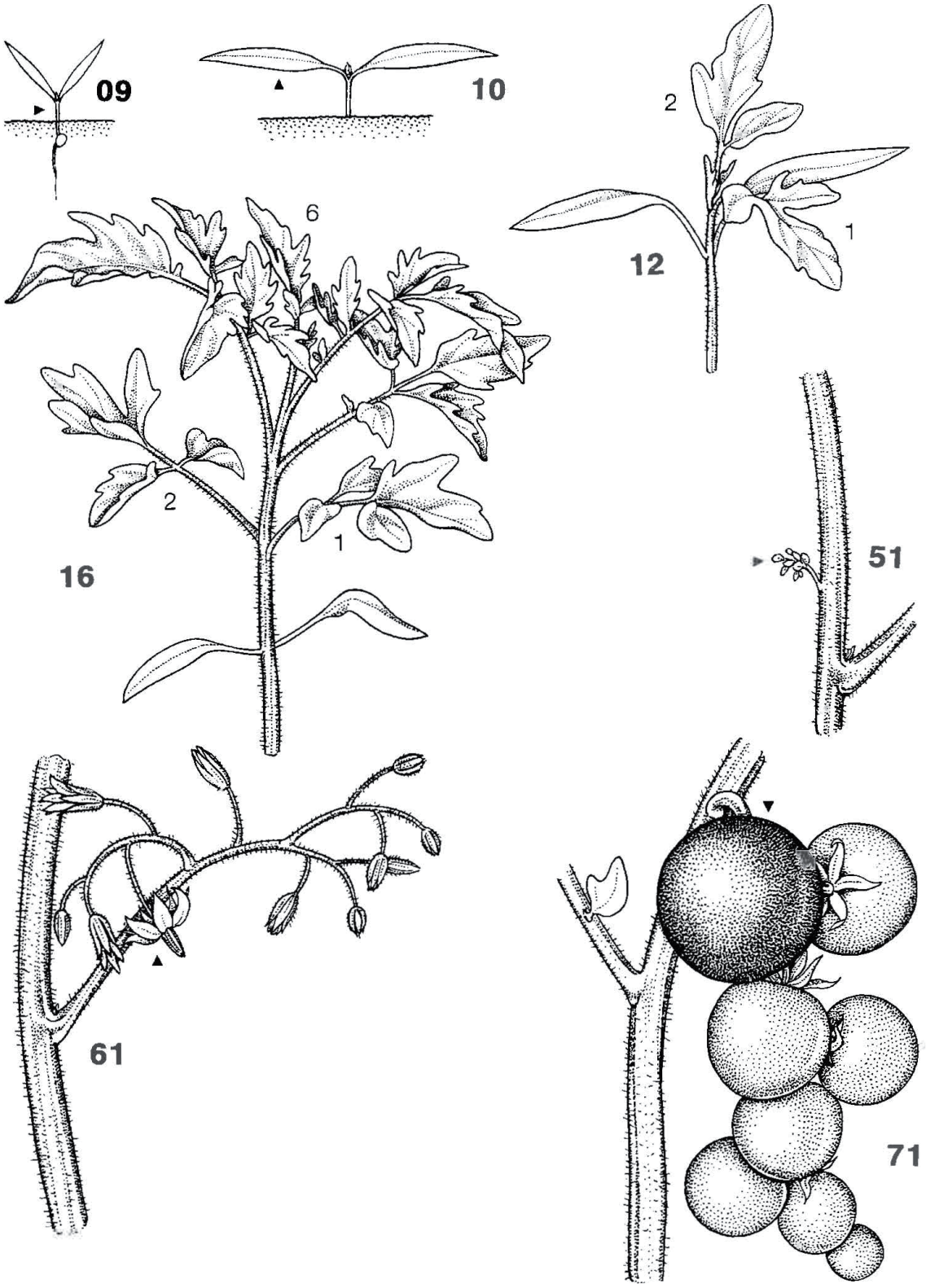
22 Leaf vegetables -not forming heads- • Blattgemüse -nicht kopfbildend- • Verduras que no forman cabeza • Légumes feuilles ne formant pas de „pommes“



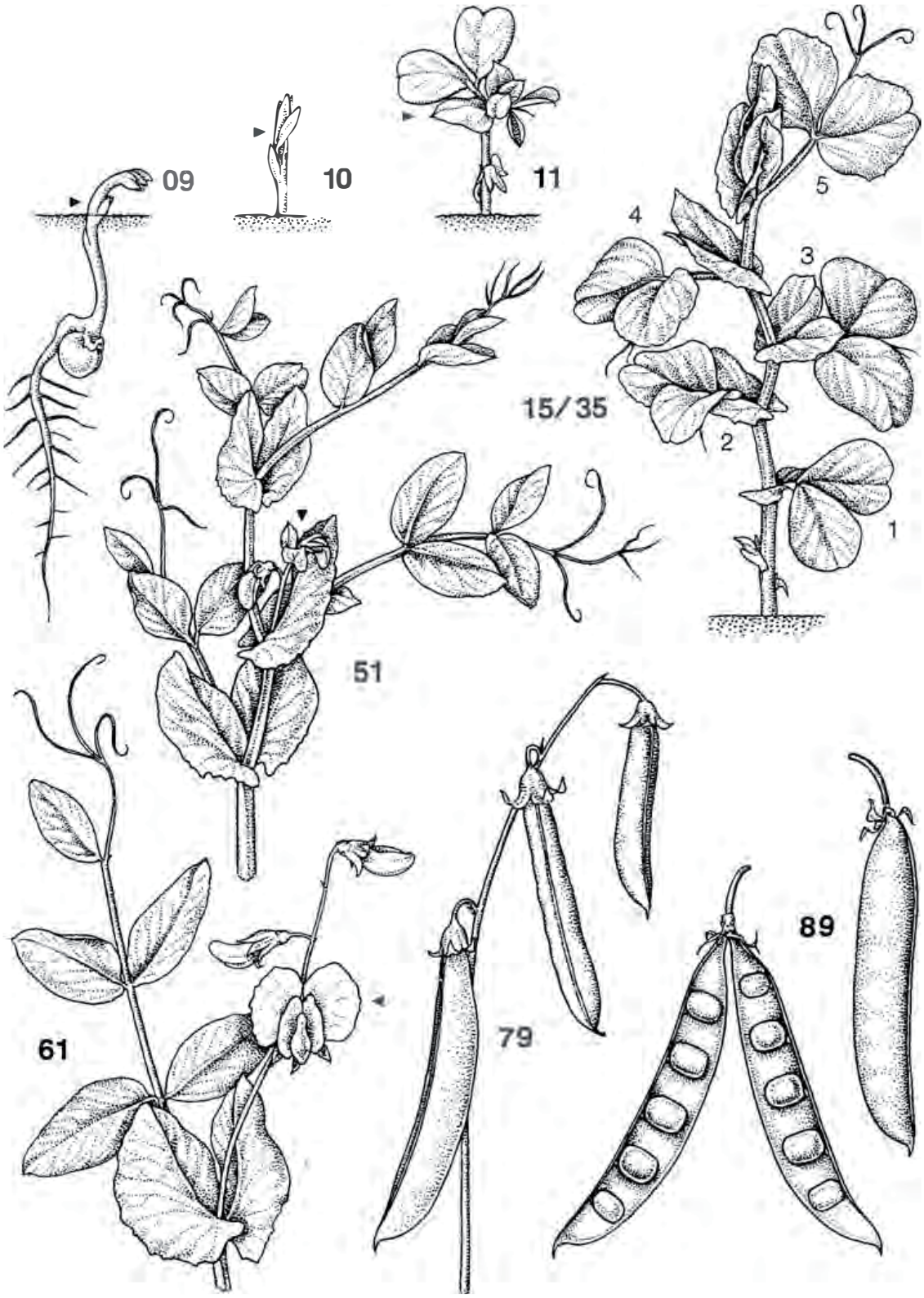
23 Other brassica vegetables • Sonstige Kohlgemüsearten •
Otras hortalizas • Autres légumes à base de chou



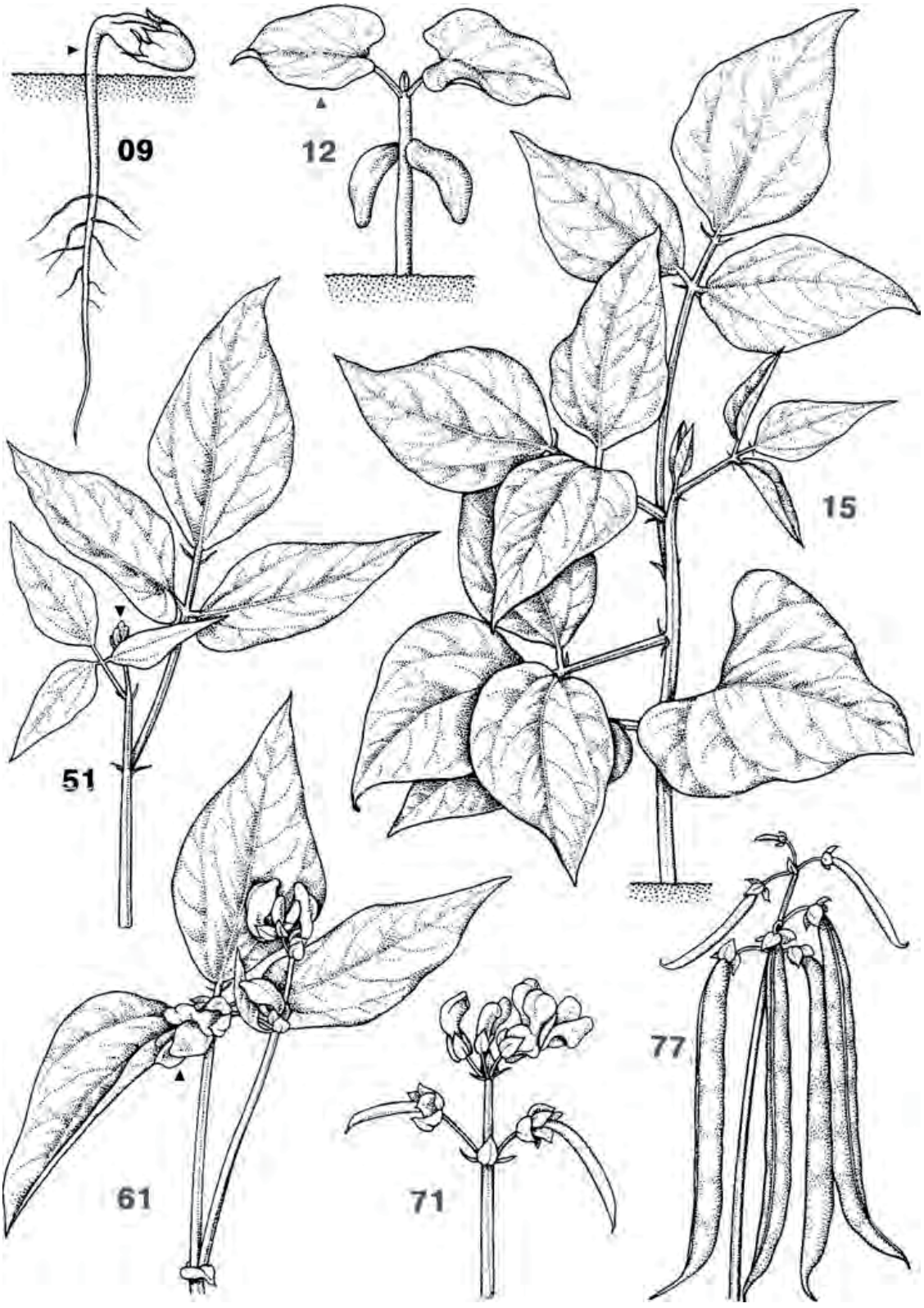
24 Cucurbits • Gurkengewächse • Cucurbitáceas • Courges



25 Solanaceous fruits • Nachtschattengewächse • Solanáceas • Solanacées

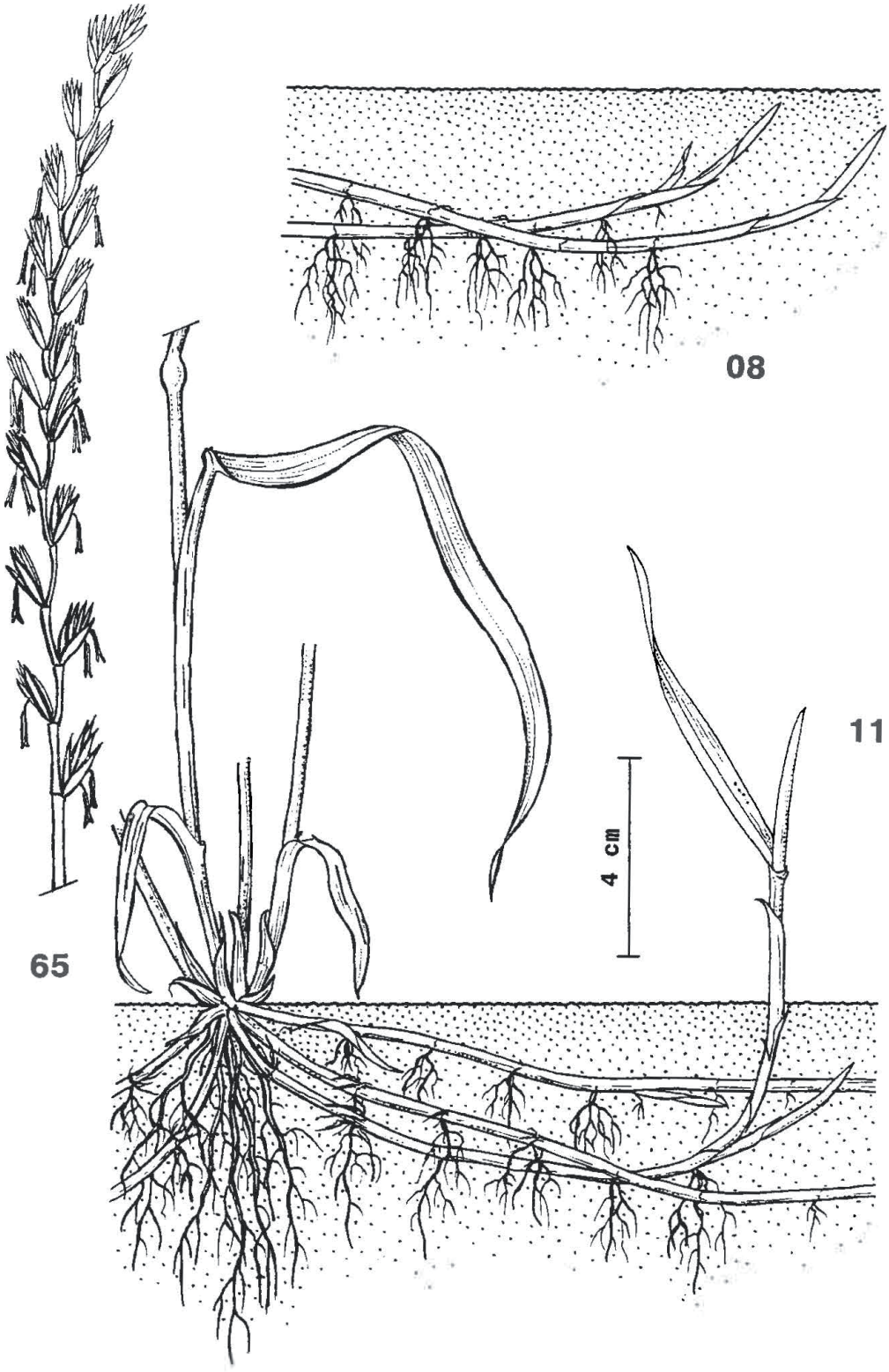


26 Pea • Erbse • Guisante o arveja • Pois



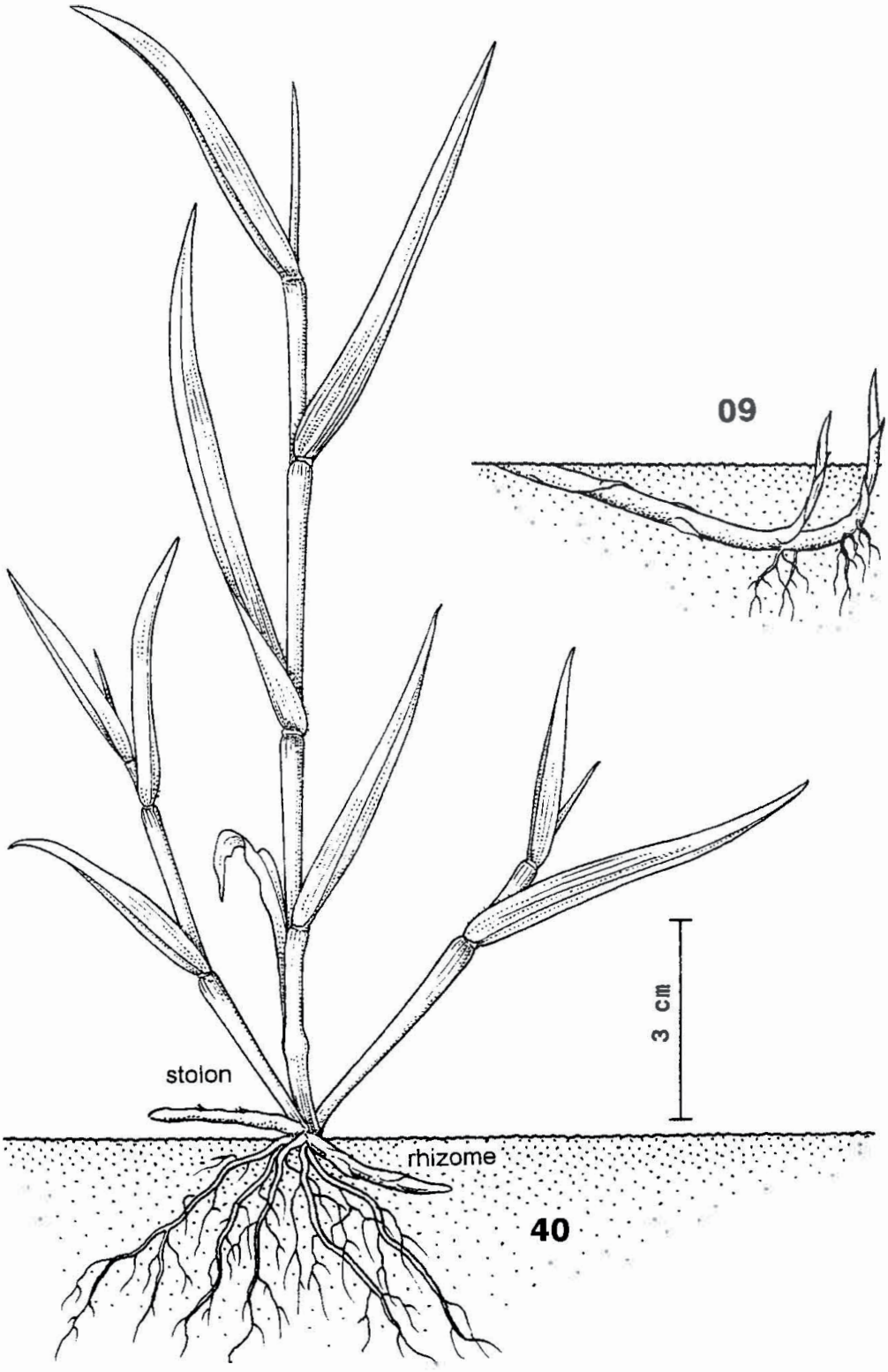
27 Bean • Bohne • Frijol / judía • Haricot

Agropyron repens (L.) P. Beauv.



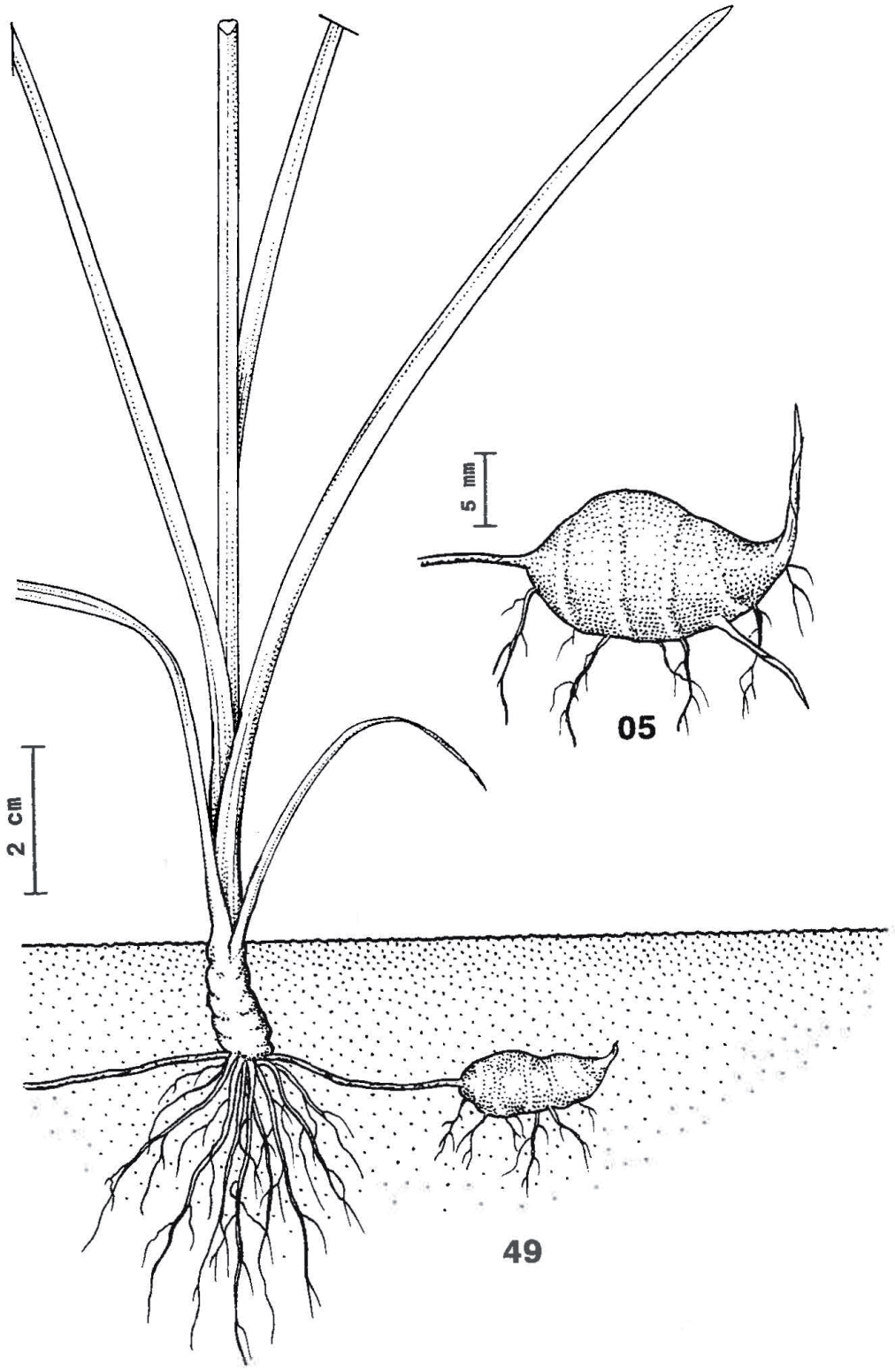
28 Weed • Unkräuter • Malas hierbas • Mauvaises herbes

Cynodon dactylon (L.) Pers.



28 Weed • Unkräuter • Malas hierbas • Mauvaises herbes

Cyperus rotundus L.

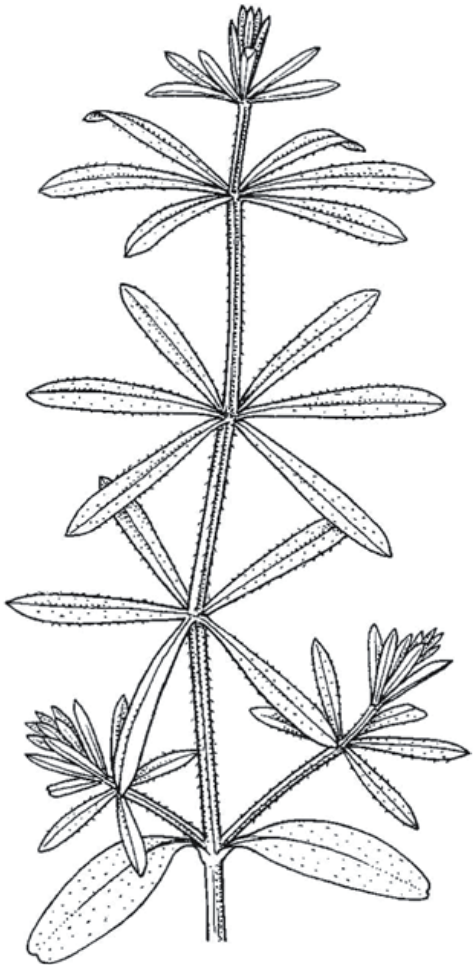


28 Weed • Unkräuter • Malas hierbas • Mauvaises herbes

Galium aparine L.

10

11



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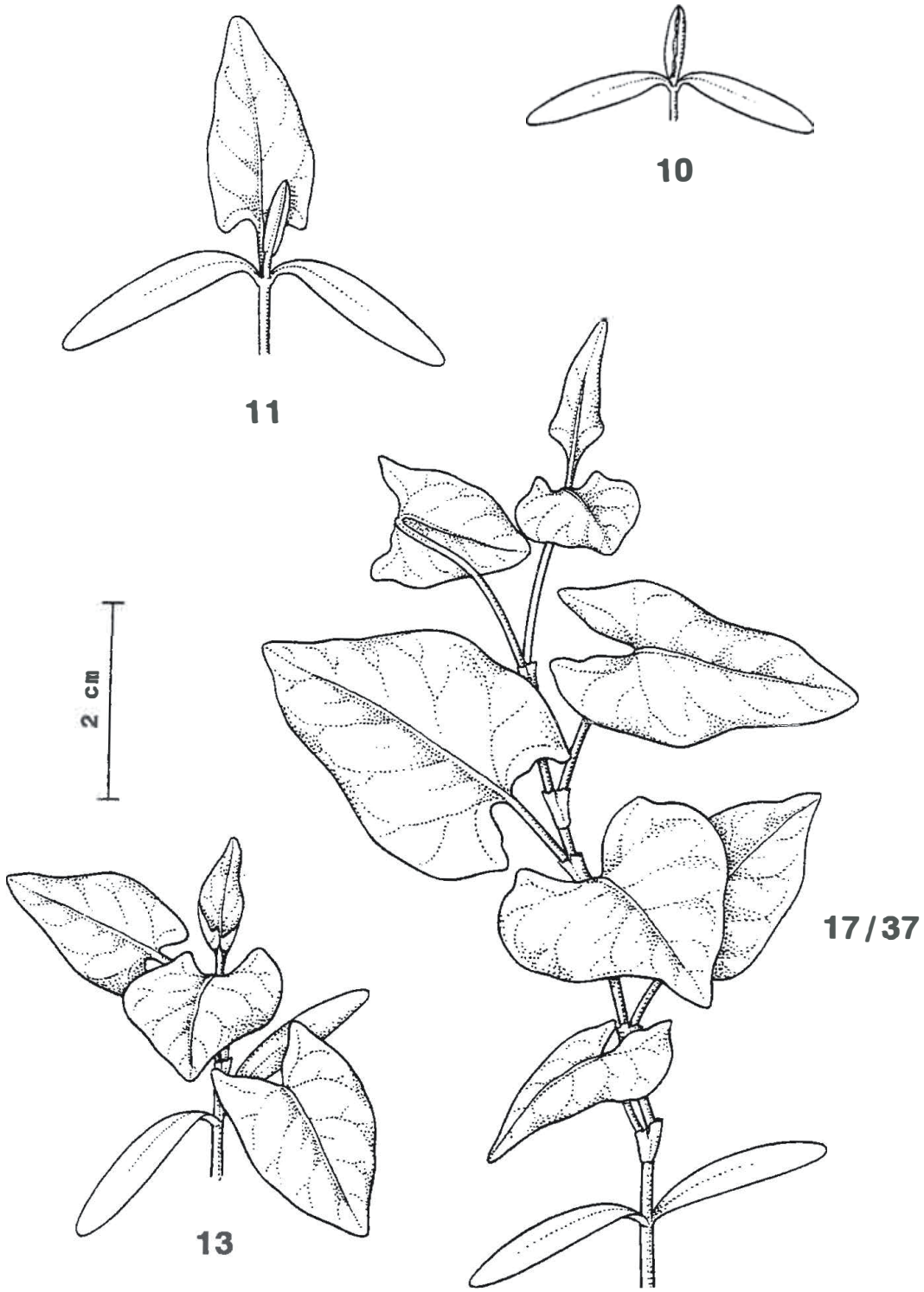
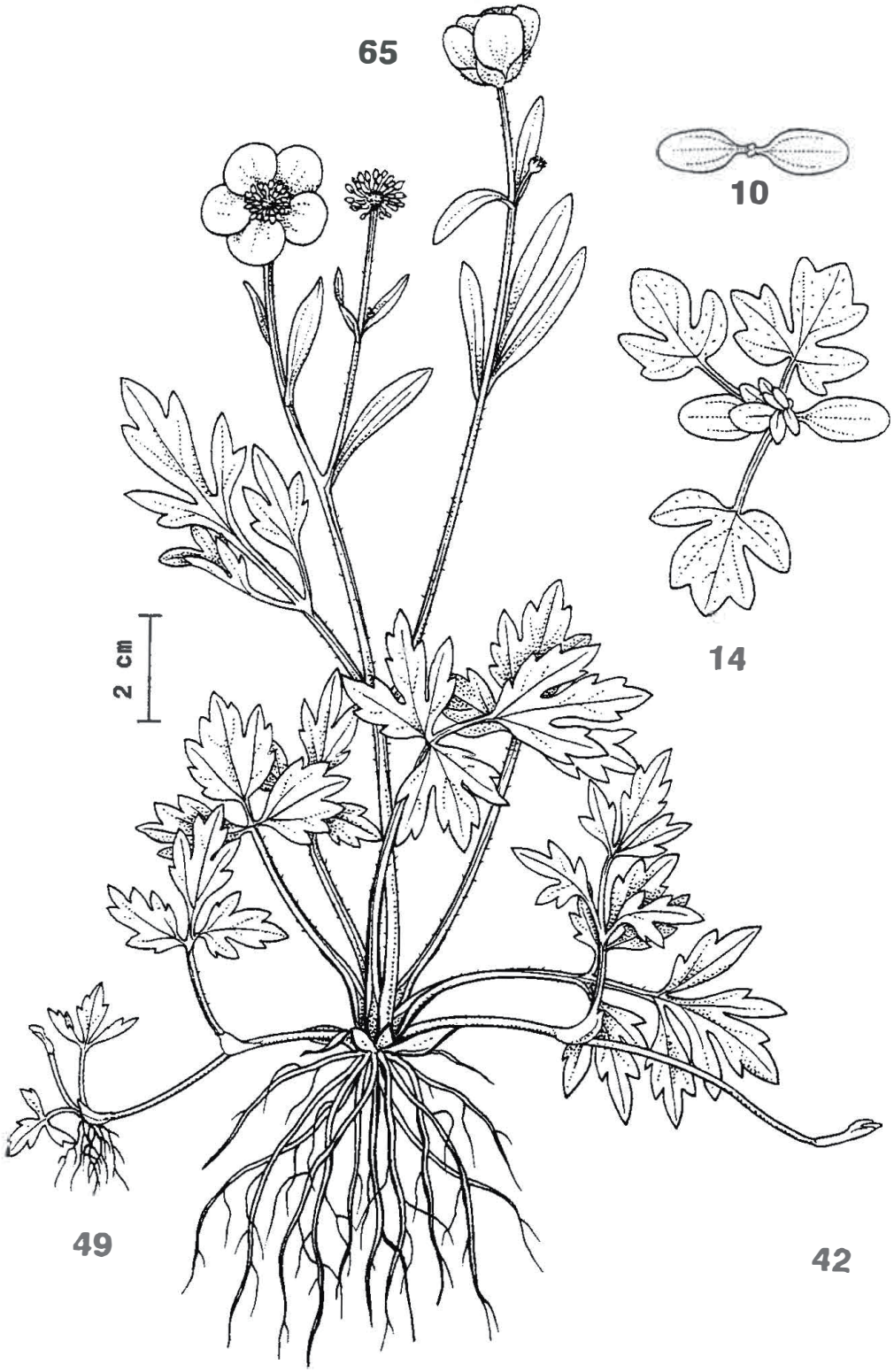
Polygonum convolvulus L.

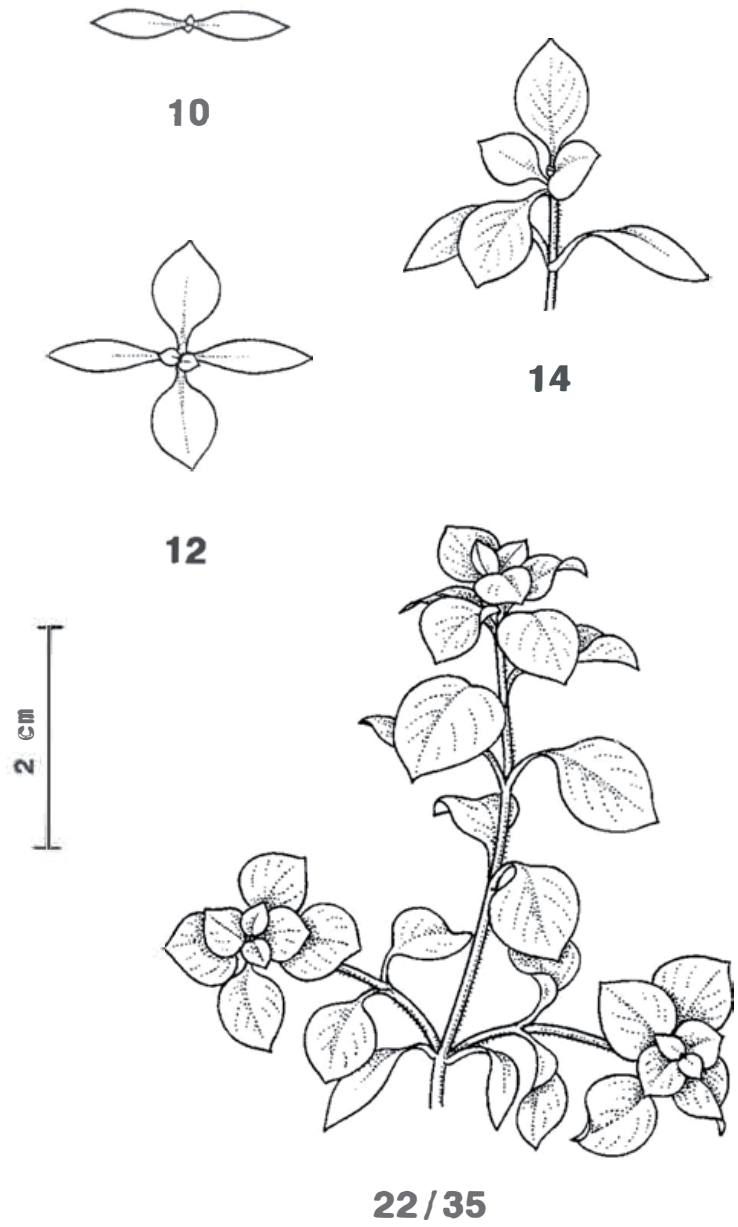


Ranunculus repens L.

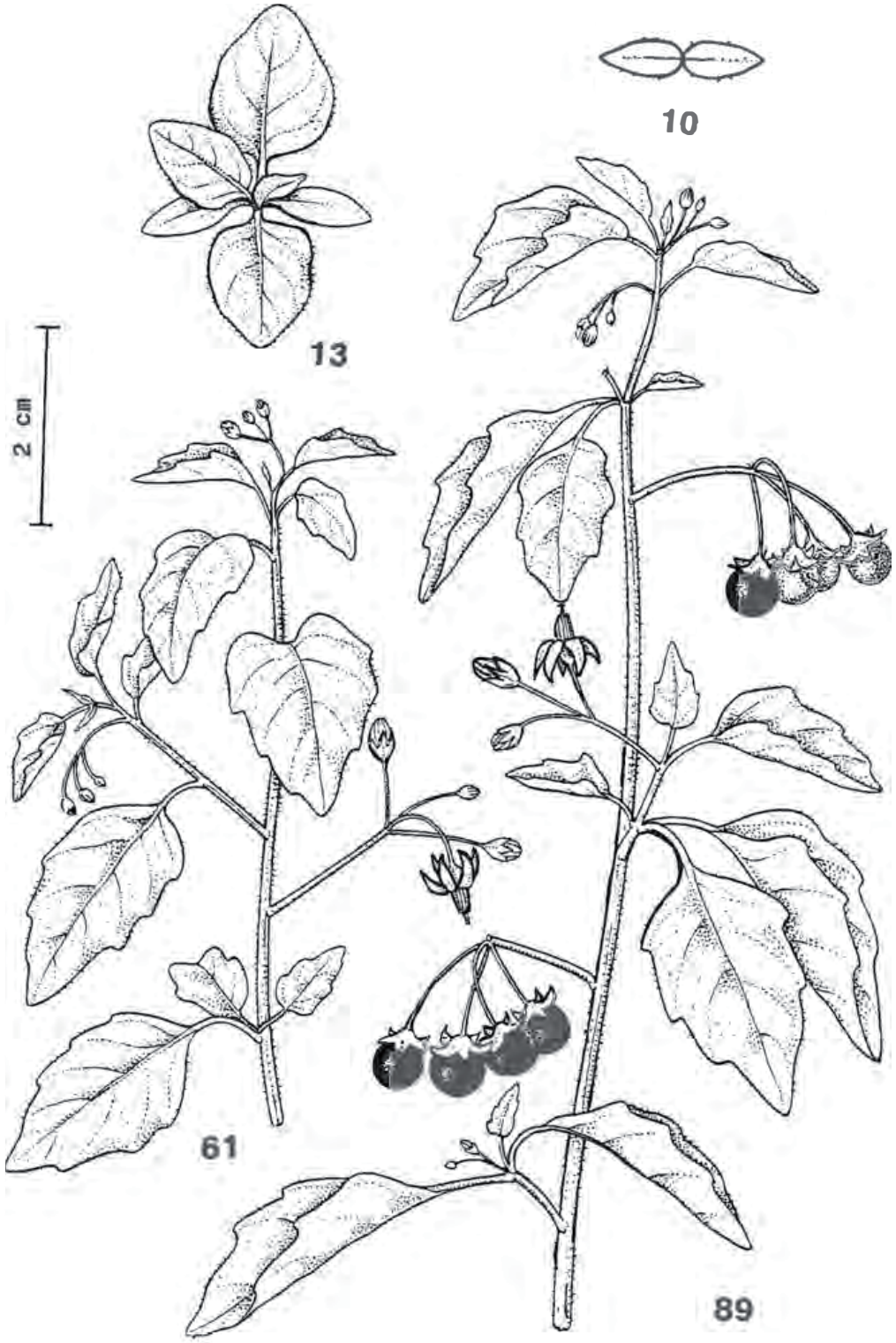


28 Weed • Unkräuter • Malas hierbas • Mauvaises herbes

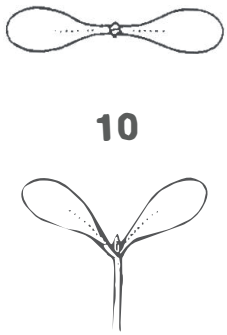
Stellaria media (L.) Vill.



Solanum nigrum L.



Taraxacum officinale Wiggers



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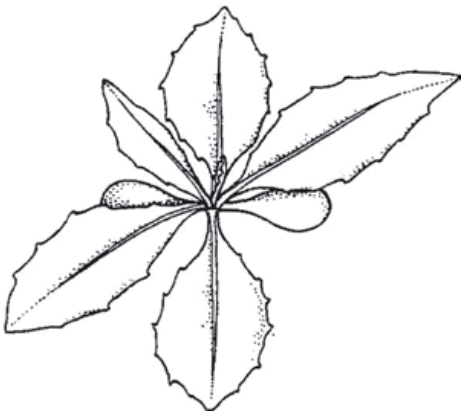

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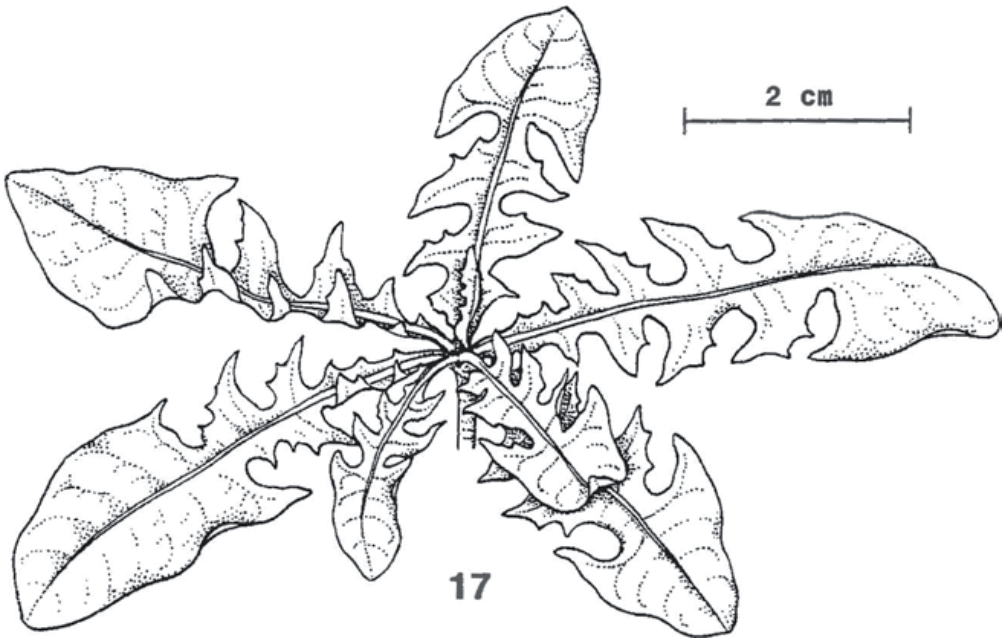

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28 Weed • Unkräuter • Malas hierbas • Mauvaises herbes

Veronica hederifolia L.