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On the 75th Anniversary of Anthroposophic Mistletoe Therapy (Original title: Die Mistel in der Zeit. Merkurstab 1995; 48:113-23. English by A. R. Meuss, FIL, MTA.)

Evolution of anthroposophic mistletoe therapy

Mistletoe has attracted special attention from antiquity, which is evident from mystery texts such as Virgil's Aeneid(1) or the later Edda,(2) where mistletoe plays a significant role in events. Pliny the Elder spoke of the great importance mistletoe had among the Celts: "They call mistletoe the 'all-healer' in their language."(3)

The plant's wide range of medicinal uses was also much appreciated in medieval times and the early part of the present age. However, the essential nature and true significance of mistletoe did not emerge until the early 20th Century,4 when Rudolf Steiner, basing himself on the science of the spirit, presented it as the medicine for cancer.(5)

It must have been a significant moment for the mistletoe spirit when it advanced from being the all-healer to being the "specific for carcinoma,"(6) that disease of our time.

The birth of anthroposophic mistletoe therapy in 1920 was preceded by a period of more than 3 years during which the basic principles were evolved. The first time Rudolf Steiner referred to the connection between mistletoe and cancer was on New Year's Eve, 1916.(7) Ita Wegman had taken this up immediately and started to produce and use a mistletoe preparation in her Zurich practice in the early months of 1917.(8) Rudolf Steiner was able to build on her initiative and present mistletoe therapy to the physicians on 2 April 1920, which was a Good Friday.

The presentation on 31 December 1916(7) marked the conclusion and summing up of a series of references Rudolf Steiner had made to mistletoe from 1904.9 His main concern had always been to show the nature of the plant by considering its cosmic origins, seeing it as a relic of the Ancient Moon period of Earth evolution. It was as if he wanted to seek mistletoe nature out in its spiritual home - or spiritual exile, as we might also put it. It was then possible to incorporate mistletoe in the ongoing stream of time.

After March 1920, Rudolf Steiner referred to mistletoe on a number of occasions, speaking not so much of its cosmic past but of its future within the Earth sphere. On 2 April 1920, he briefly presented mistletoe as a cancer medicine and then went on to say: "It will entirely be a matter of finding the right way of processing the fruit, though, of course, very much in connection with other mistletoe qualities." He emphasized "utter dependence on the method used to process mistletoe substance,"(5) and also said the aim was to change the "active element in the mistletoe process into a different process of aggregation,"10 with the "medicinal quality of Viscuni only arising in the process" (my italics - H.R.).(6)

Three years and three months passed between the two stages in the evolution of mistletoe therapy - seeking out past origins of mistletoe and indicating its future. During this time, mistletoe therapy developed quietly, becoming part of present Earth life.

The time form of mistletoe development
The three years and three months interval emerged in the course of basic studies on the mistletoe issue,(11) and it seemed worthwhile to go more deeply into mistletoe nature. The question was if an inner relationship existed between this interval and the time needed for mistletoe development. Beginning in 1992, a comprehensive overview was sought - a panoramic view of mistletoe development, as it were.

Initially, the work was based on Ottilie Zeiler's paper on the annual rhythms of mistletoe growing on hardwood trees.(12) Further details were obtained from the work of Thomas Goebel and Rolf Dorka,(13) and reference was also made to Peter Goeding's essays on mistletoe morphogenesis.(14)

Going in reverse order from mature fruit and embryo to flower and then branch development, we found a time of about two years and two months. Following Zeller,(12) we took completion of embryonic development by about the end of September as our endpoint, the starting point being the first signs of a new generation of shoots in the leaf axils of the preceding generation, which may be seen from August onwards. Figure 1 shows this time aspect in the diagrammatic form evolved by Zeller.(12)

If the mistletoe leaves, which almost completely envelop the branch apex, are carefully removed in August, it will be apparent to the naked eye that development is quite advanced. The two small leaf primordia are easily separated to show the extremely compact stem element forming the base. Taking a closer look, it is actually possible to see the apex of the future generative shoot, the bud of the inflorescence, already present between the leaf primordia. This advanced stage must clearly have been preceded by other developmental stages.

Interest then focused on the time when the very first sign of branch development might be seen. Stereomicroscopic studies, mainly on mistletoe growing on apple trees (Viscum album ssp. album on Malus domesticus) started in the Spring of 1993, and continued in 1994 to check, deepen and extend our findings.

In the beginning of May 1993, we found an early developmental stage and were able to follow this through subsequent stages. The primordia of the

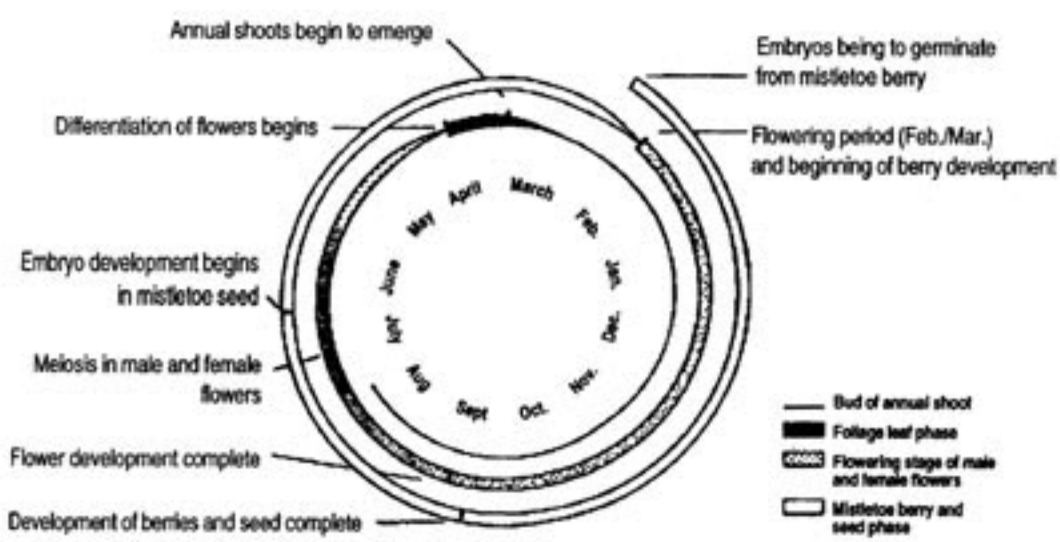


Figure 1. Annual rhythm of flower, fruit and embryo development in mistletoe growing on hardwood (Viscum album ssp. album)(11)

two scale leaves (cataphylls) were still in the cell division and elongation stage. They grew towards each other above the as yet undifferentiated central meristem, enveloping it.

During the weeks of May, the primordia of the mistletoe leaves developed from the central meristem. By mid-June, these had differentiated into individual leaves, though still extremely soft and delicate. Pulled apart they revealed the remaining central meristem beneath their bases; this was still largely undifferentiated (Fig. 2).

By early July, the meristem had differentiated into the bud of a short shoot or inflorescence, now with generative orientation (Fig. 3). It consisted of two vaulted bract (hypsophyll) primordia enclosing a space with meristem at its base. According to Zeller,(12) this flower meristem rests for about 9 months. Further developmental stages and differentiation of the floral organs may be seen the following April.

The leaf, stem and bract primordia of the young shoot consolidated during the weeks following early to mid-July but did not show much increase in size. The leaf tips of the new shoots in the axils of the preceding leaf generation became just visible, however. Real growth and development did not start until the following April.

When does development of a mistletoe branch begin?
The question was if the early development stage seen in the beginning of May was in fact the first beginning of an individual branch. The answer was

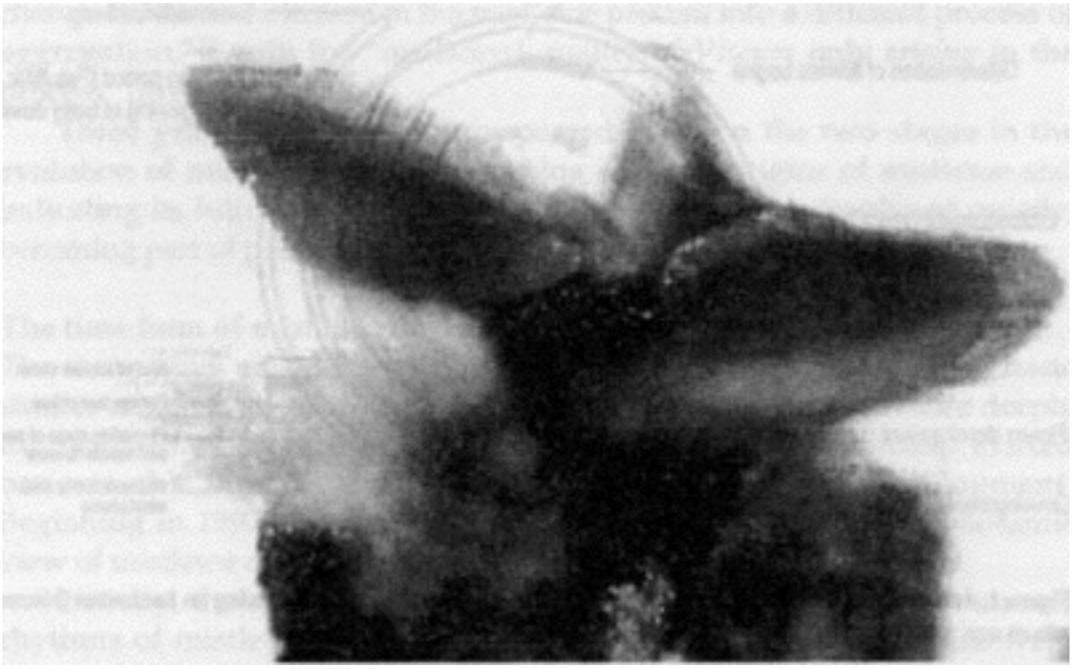


Fig. 2. Early stage of new mistletoe branch. Photograph taken 14 June 1993. Between the opened-out leaf primordia lies the central meristem which produces new, as yet undifferentiated layers of cells. The scale leaves (left foreground and right background) are blurred due to photographic enlargement (x 50).

Fig. 3. Developing mistletoe branch seen from above. Photograph taken on 15 July 1994. The two scale leaves and leaf primordia have been opened out; between them lies the bud of the inflorescence or short shoot made up of two bracts (x 30).

in the negative and ways had to be found to establish the first crystallization point, the germinal source point of a new mistletoe branch.

It seemed likely that earlier and more accurate stereomicroscopic studies would reveal a visible form of the developing growth point earlier on in the year. In 1994, when the investigations of the previous year were repeated and done at greater depth, we did, in fact, (re)discover the developing scale primordia and the central meristem they enclosed in late March.

The assumption was, however, that the actual beginning must come much earlier in the time stream and was beyond the detection limits of stereomicroscopy.

It was evident that stereomicroscopy could not reveal that first beginning nor the early developmental stages (first cell divisions in the initial meristem). Having obtained our first series of stereomicroscopic results, we therefore began in the Fall of 1993 to use mental activity to try and find the moment when the initial meristem becomes individualized, thus marking the beginning of branch development.

We started by considering the development of axillary buds from axillary meristem which is described as a general case in botany textbooks.(15) Figure 4 shows this in diagrammatic form.

Axillary meristems develop from the axils of differentiating leaf primordia at the shoot apex of typical dicotyledonous plants. At the same time, the central meristem continues to grow by means of cell division and elongation, creating the basis for the development of further leaf primordia with their axillary buds. The question was: exactly when would it be possible to speak of individualization of an axillary meristem against the general meristematic or undifferentiated tissue of the apical cone? The diagram (Fig. 4) suggests

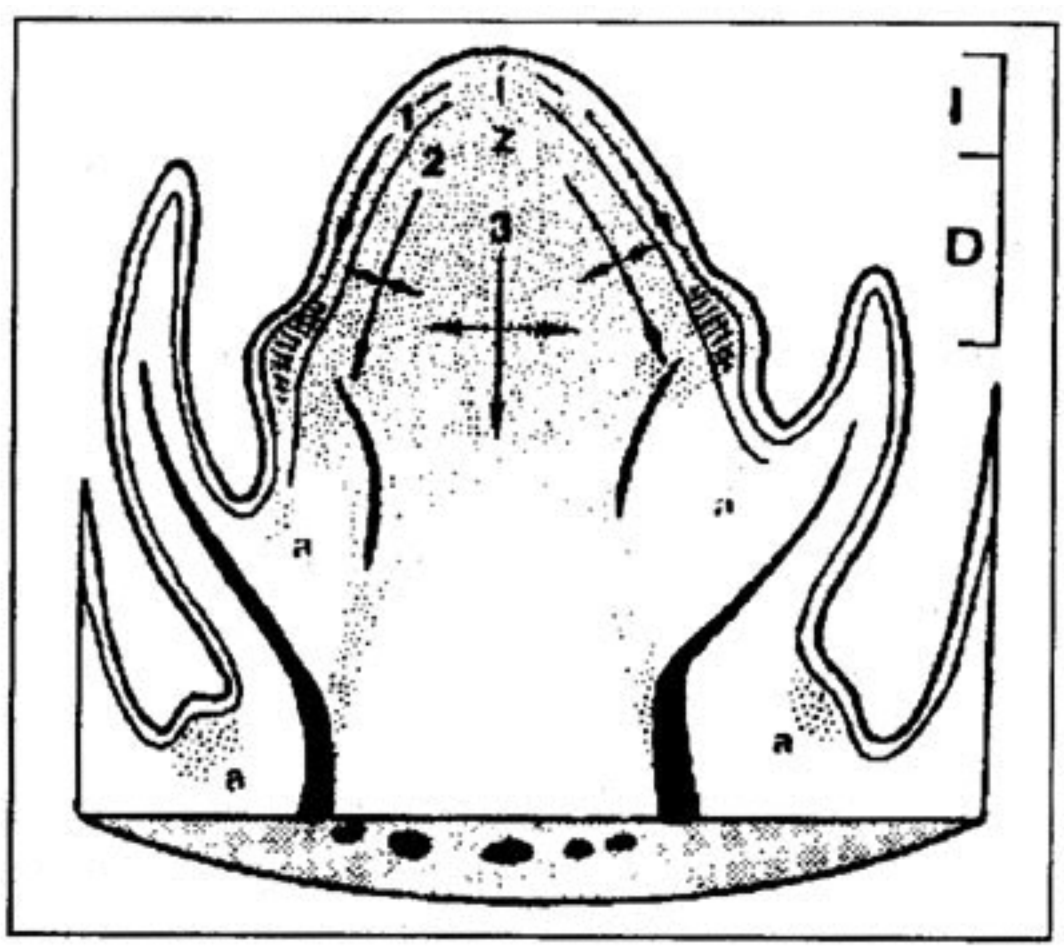


Fig. 4. Longitudinal section of shoot apex of a seed plant" I = initial zone;
D = differentiation zone;
i = initial apical group with central meristem cells;
z = central meristem;
a = axillary meristems; arrows indicate main directions of division and/or growth;
1,2,3 = stem and leaf primordia (1), bark and meristem cylinder (2) and medullary parenchyma (3);
dotted areas = meristematic zones;

black = vascular bundles developing
in leaf primordia.

that this relates to the extent of differentiation or, in other words, loss of meristematic potential in the surrounding tissues.

Axillary meristems, therefore, develop when leaf primordia arise at the shoot apex and nodal development is also initiated for the future shoot. The moment the tissue of an evolving leaf primordium begins to differentiate, with tissues cut off by the central meristem beginning to differentiate into a stem, the axillary meristem remains as an island among the increasingly more differentiated tissues in the region of the shoot apex.

Mistletoe shoots always develop only one pair of opposite leaves. The development of the meristematic island on which the future shoot will be based must, therefore, be connected with the degree of differentiation in the delicate leaf primordia, which is likely to begin in late May or early June. Another condition is that the central meristem remaining between the two leaf primordia cuts off further cells, thus providing the basis for subsequent generative development, i.e. begins to differentiate into the compacted stem and the bract primordia of the short shoot. As already stated, this had not happened by mid-June when central meristem and axillary meristems were still uniform, with the cell layers showing no signs of further differentiation (Fig. 2).

The stage we were looking for, when individualization of the new initial meristem is complete, is only reached at a later point in time, in late June or early July. If the delicate, still soft and pliable leaf primordia are pulled apart, a new bud can be seen developing between their bases. Figure 3 clearly shows the two bracts that will envelop all subsequent stages of development. Dissection will reveal the compact stem element of the short shoot beneath them.

What has been gained through mental activity based on stereomicroscopy may also be accessible by a third route, using careful observation. In a recently published paper,(16) Thomas Goebel shows time aspects of mistletoe development seen in sections examined under the microscope. These essentially substantiate the above results, especially with regard to early developmental stages apparent in the initial meristem in February/March. Goebel's work was concerned with different aspects, which is why he did not determine the first appearance of the initial meristem and did not clearly define the earliest initial meristem stage in October. Sections made from specific mistletoe tissues in June and July, suitably stained as required, would probably make it possible to determine the moment when a new initial meristem begins to develop more accurately.

Three years and three months of mistletoe branch development
New branch development is thus individualized in an initial meristem in early Summer, between mid-June and early July. It may be assumed that the Summer Solstice on 21 June marks a threshold in the process. It is probable that differentiation from general tissue development leading to the meristem of a future branch occurs immediately after the Summer Solstice.

The meristematic island will then rest for about nine months, with the primordia of stem, leaf and inflorescence differentiating out from it the following Spring. Another nine months rest follows from July to April, when the new stems and leaves open out in the sunlight. They will show the characteristic release movements(13) before they gradually let the short shoots with the flower buds appear which matured hidden from sight. The following February, about 32 months after that moment of individualization, those branches will come into flower. Another 7 months later, in late September of the 4th year, the mistletoe embryo will have matured in the fruit. The period from flowering to maturation of the fruit in November is about 9 months.

Table 1 shows the stages in the development of a mistletoe branch as it was established in our own work and from the literature consulted. (12-14,16)

Table 1. Evolution of mistletoe branch from initial meristem to mature embryo and fruit. Text refers to what happens from a particular moment within the year.

from late June (Year 1) Initial meristem of mistletoe branch individualizes in axil between primordia of leaf and inflorescence.
from late September Initial meristem rests, no further development.

from late December Initial meristem still resting.
from late March Primordia of two scale leaves begin to develop from initial meristem. These will later protect the residual central meristem. Towards mid- or late May, the two leaf primordia begin to evolve from the swelling meristem.
In mid-June, the two individual mistletoe leaves can be pulled apart. The residual central meristem at their bases produces further, as yet undifferentiated cell layers.
from late June (Year 2) Compact stem and two bract primordia of future inflorescence
develop from cell layers produced by central meristem. The bracts enclose a space with residual meristem at its base. The primordia of the new mistletoe branch gradually consolidate, with only minimal increase in size.
In August, the young leaf tips emerge slightly from the axil of the preceding mistletoe branch generation.
from late September Mistletoe branch rests, with no further development.
from late December The young mistletoe branch is quiescent, with no visible
development.
from late March In early Spring the young mistletoe branch begins to unfold. The scale leaves remain behind and wither away; the stem elongates. The tender leaves raised to the light separate from each other and broaden.
From May, the leaf bases, initially closely adjacent, are pushed apart as the bud of the inflorescence emerges into the light. From mid-May, the residual meristem in the generative bud begins to develop into a cupule. In late May, the new mistletoe branches begin to show characteristic growth movements to extricate themselves from their negative geotropic orientation.
Towards mid-June, four perigone lobes develop on the upper margin of the cupule.
from late June (Year 3) Extrication movements of the young branches decrease, and elongation of stems and leaves ceases for the first year. In early July, two carpels develop from the central meristem inside the flower bud at the base of the cupule which is closed up by the perigone lobes. They begin to fuse from periphery to center and downward from above. While the remaining outer carpel tissue gradually differentiates, the fusing marginal layers inside remain embryonic. This embryonic

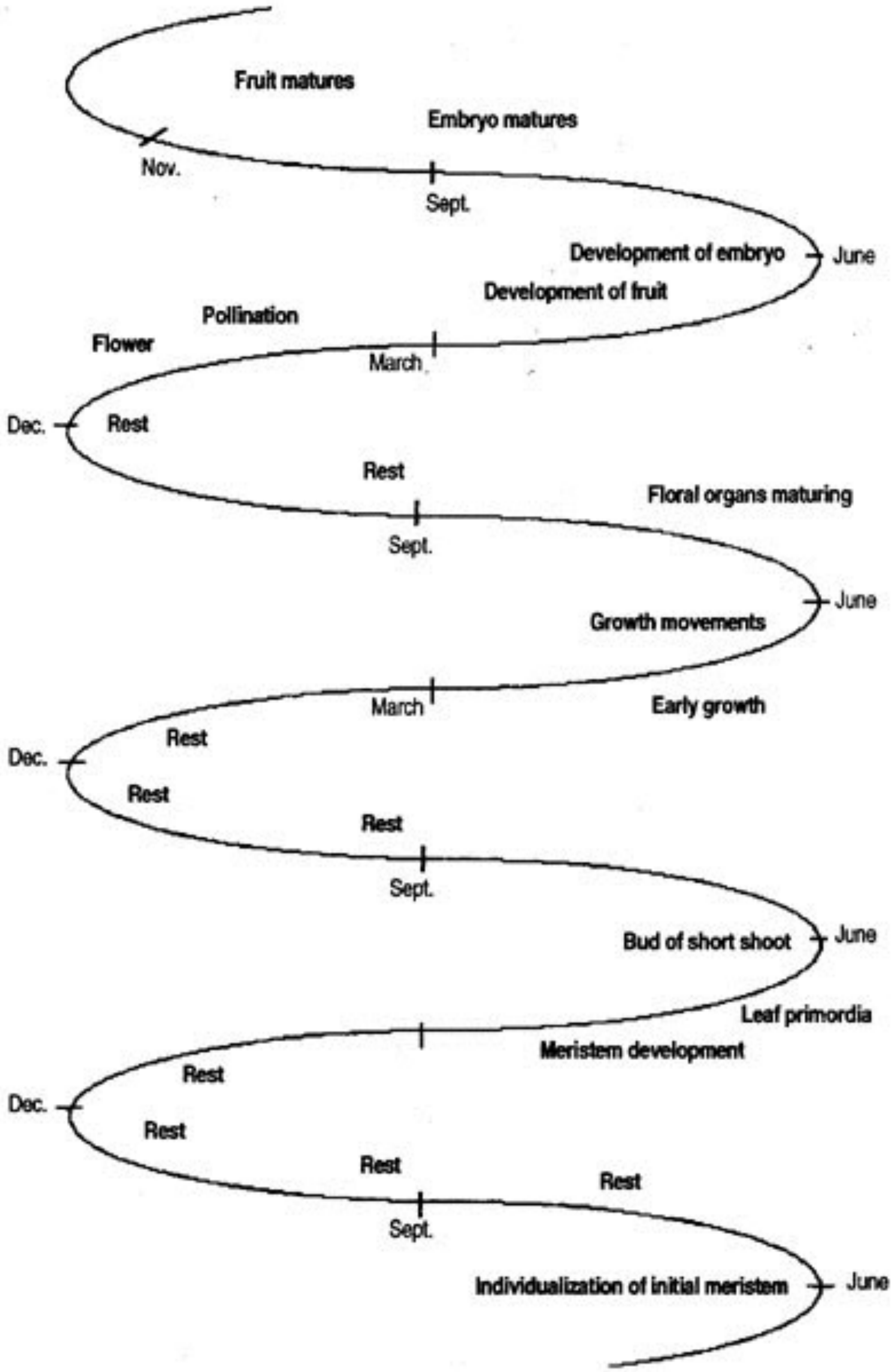
marginal tissue gives rise to the "central body," the gap between the fusing carpels filling with tissue that is initially gelatinous and condenses later. In late July, 7-9 embryo sac mother cells usually develop on the base of the bottle-shaped nucellus.
In August, 1-4 of these develop into embryo sacs, elongated tissue differentiations with two nuclei: embryo sac nucleus and ovum.
In early September, the upper parts of the nucellus develop into a papilla-like form, the stigma, which extends almost to the enveloping perigone lobes.
Parallel to this, the two-grained pollen grains have differentiated out in the male flowers from June to September.
from late September The mistletoe branches and the organs which have differentiated out in the flower buds rest.
Only the short shoots emerge slightly from the gap between the two mistletoe leaves in the weeks that follow, and individual flower buds emerge from their enveloping bracts.
from late December The flower buds rest until the Winter Solstice. In early January, the first flower buds - male usually before female - begin to open. In February, flowering is at its height. Insects, such as flies, ants or hoverflies, carry the pollen grains to the female flowers where they begin to germinate on the stigma.
from late March The vegetative cell nucleus of the germinated pollen grain has fused with the embryo sac nucleus and the generative nucleus with the egg cell of the embryo sac to form a zygote. The mistletoe fruit begins to swell, with further tissue differentiation proceeding inside:
- Continually expanding, cupular and carpellary tissues fuse to form the exocarp, the tough, leathery fruit skin.
- The swelling central body differentiates on the outside into the mesocarp, a viscin-containing mucilaginous layer, with cell walls dissolved, and the denser endocarp with lignifying vascular bundles.
- Inside the endocarp, endosperm continually produced from the fusion of vegetative pollen nucleus and embryo sac nucleus closes up around the resting zygote, soon enclosing it completely.
from late June (Year 4) The mesocarp differentiates into an outer layer attached to the exocarp and an inner layer which remains connected with the endocarp. It becomes progressively more mucilaginous and sticky.

Early July sees the beginning of embryonic development within the endosperm. The primordia of the cotyledons develop at the center of the nutritive reserve, with the hypocotyl slowly reaching its periphery. From mid-August, the mistletoe leaves, which had expanded in April and again in May, drop off.
from late September   Embryonic development is complete with the maturing of the vegetative cone of the shoot between the cotyledons. From November onwards, the exocarp loses its color so that the green endosperm and green mistletoe embryo are based in muted light as they rest through Winter and until the following Spring.

Figure 5 gives an overview of mistletoe development from initial meristem to mature embryo and fruit. It shows that a mistletoe branch takes about 39 months, which is almost exactly 3 years and 3 months, to develop to the point of producing a mature embryo. If the mature fruit is taken as the end-point, the period is 3 years and a good 4 months.

This time sequence of mistletoe development initially only applies to the two main branches growing from the axils of two opposite leaves. Subsidiary shoots arising from the axils of the scale leaves which initially enveloped the growth points of main branches have to be considered separately. The same applies when short shoots rather than branches develop from the axils of the scale leaves which flower and produce fruit without developing stems and leaves. These aspects have been left out of consideration in the present study.

It also needs to be considered that the starting and endpoints of mistletoe development may shift depending on the climate in different latitudes. Deviations from the 3 year and 3 or 4 month development period would be



Fruit matures
Embryo matures
Nov.
Sept.
Development of embryo
June
Development of fruit
Pollination
Flower
March
Dec.
Rest
Rest
Floral organs maturing
Sept.
June
Growth movements
March
Early growth
Rest
Dec.
Rest
Rest
Sept.
Bud of short shoot
June
Leaf primordia
Meristem development
Rest
Dec.
Rest
Rest
Rest
Sept.
Individualization of initial meristem
June

Fig. 5. Mistletoe branch development from meristem indivkiualization to mature embryo and fruit

insignificant, however.

Understanding of anthroposophic mistletoe therapy may be increased by taking account of the correspondence between the time interval needed for development of a new mistletoe branch and a new embryo and the time interval between Rudolf Steiner's first reference to the clinical significance of mistletoe (31 December 1916) and his presentation of mistletoe therapy when its basic principles had already been established (2 April 1920). Both, the development of the mistletoe fruit or, rather embryo and the development of anthroposophic mistletoe therapy by Rudolf Steiner and Ita Wegman cover a period of 3 years and approximately 3 months.

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