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Development and structure of hawthorn seeds (*Crataegus* L.) from species occurring in Poland

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Abstract

The development, internal and external structure of seeds of *Crataegus monogyna* Jacq., *C. curvisepala* Lindm., *C. lindmannii* Hrabět-Uhr., *C. oxyacantha* L. *em.* Jacq., *C. palmstruchii* Lindm., *C. macrocarpa* Hegetsch were investigated. It was found that the embryo development is specific, and the development of endosperm precedes that of the embryo. In mature seeds of the examined species endosperm is present under the seed coat and the embryo with large cotyledones and radicle is completely immersed in it. The external appearance of the seeds of particular species differs, and on this basis their specific appurtenance may be determined.

INTRODUCTION

Six hawthorn species have been found in Poland, and within them several units of lower order (subspecies, varieties) and seven interspecific hybrids have been distinguished (Gostyńska-Jakuszewska 1978, 1979). The present study deals with the development, internal and external structure of seeds in taxons of the rank of species. Further publications will concern seeds of lower orders and hybrids.

METHODS

Seed development from early stages of the globular embryo up to maturity was established on the basis of microtome slides 12-20 μm thick prepared by the paraffin method and stained with haematoxylin after Mayer. They were subjected to the following treatments: PAS and Millon's reaction with Sudan III. The sections along the seed long axis

and cross-sections in the widest part were prepared, usually more or less at mid lenght. From each plant specimen 50 seeds were measured from fruits with a typical number of stones for the given species. In some cases a small number of fruits with an untypical number of fruits was available, and then additional measurements (30 or 25) were taken of a smaller number of seeds. When fruits with an atypical number of stones occurred sporadically, the seeds from these fruits were not measured, only in the description mention of this was made. Seed measurements were performed under a stereoscopic MBS-2 microscope at a magnification of ×16 (with an accuracy up to ±0.05 mm) and at ×32 (with an accuracy up to ±0.025 mm). Drawings of the seeds were made by means of the drawing apparatus MNR-1, PZO.

Species frequent in Poland are represented always by samples from three sites, whereas rare or very rare species were taken from a smaller number of sites. Material for investigation originated from the following localities:

1) Tuł mountain (621 m a.s.l.) in Cieszyn foothills,
2) Życzanów near Rytro in the Poprad valley, district Nowy Sącz,
3) Chobot in the Niepołomice Forest near Cracow,
4) Borek Fałęcki — a district of Cracow city,
5) Przegorzały — a district of Cracow city,
6) Międzylesie in the Kłodzko depression,
7) Zelejowa Góra Mt. near Chęciny, Kielce district,
8) Biernatki near Kórnik, Poznań district,
9) Aleksandrów Kujawski, Włocławek district,
10) Pręgowo near Gdańsk.

The material originated from the collections of the authors (aut.), of A. Boratyński (B.) and M. Gostyńska-Jakuszewska (G.-J.). The localities will be quoted according the above numeration and name abbreviations.

RESULTS AND DISCUSSION

DEVELOPMENT OF EMBRYO AND ENDOSPERM

The genus *Crataegus* comprises species forming seeds sexually or apomictically. Embryo development may proceed by way of parthenogenetic development of the egg cell, however, for the formation of endosperm, fertilization of the secondary nucleus in the embryo sac is indispensable.

Embryological studies showed that the embryo does not develop according to any of the types distinguished by Johansen (1950, quoted after Rodkiewicz 1973). Owing to the irregular somewhat slanting position of the first cell wall in the prembryo, the subsequently forming walls in the pro-embryo give a lumpy cell arrangement

(Fig. 1). A similar embryo development was noted earlier by Radionenko (1963) and Czosnowski (1966) in *Prunus armeniaca* and *P. cerasifera* (*Rosaceae*).

The globular form of the embryo persists long in the hawthorn. The first globular stages are observed shortly after overblowing of the flowers in the beginning of June. In developed but still green fruits at the beginning of September the embryo was not yet differentiated. Simultaneously with embryo development endosperm starts to form in the central cell of the embryo sac. Schnarf (1931) and Davis (1966) consider this type of endosperm as a characteristic feature of the family *Rosaceae*.

The first divisions of the zygote and of the primary nucleus of the endosperm occur simultaneously. In later stages a desynchronisation of development occurs, owing to more intensive divisions of the endosperm.

In early stages of embryo development the free nuclei are localized in the micropylar part of the embryo sac (Fig. 2). The four-celled embryo is accompanied by 8 endosperm nuclei, and the eight-celled one by 12-16 ones. The multicellular embryo in the globular stage is surrounded by dense cytoplasm in which numerous nuclei are present. In later developmental stages the endosperm nuclei occupy the central, and later the chalazal part of the greatly elongated embryo sac (Figs. 3 and 4). In the central strands of cytoplasm joining the two poles mitotic divisions are longest observed. Anaphase and telophase mitotic figures do not show any disturbances. In this strand the differentiation of the sizes of nuclei could best be seen.

Rychlewski (1961), Trela (1963), Pogan (1964) and Turała (1966) point out the differences in size of the endosperm nuclei which are the effect of raised polyploidy. It may occur on account of mitotic disturbances or owing to endoduplication processes. Other factors such as the degree of hydration, or protein synthesis may also cause an increase of the nuclear volume (D'Amato 1952).

The lack of distinguishable metaphase plates in the examined material does not allow to decide unequivocally the causes of the above mentioned differences in the size of the nuclei. The endosperm preserves its nuclear character for a long time. In this period the nuclei are large, oval, usually with several nucleoli. Building of cell walls usually starts at the embryo sac walls. At the moment of cellularization the volume of the nuclei decreases. They become spherical, usually mononucleolar and lie in the centre of the cell. The cytoplasm is poorly stainable. The cells of the endosperm tissue are small, filled with storage material in spherical form. The PAS reaction was negative, but after those with Miller's reagent and Sudan III, storage proteins and lipids were found both in the endosperm and the cotyledones.

INTERNAL STRUCTURE OF MATURE SEEDS

The seed coat is extermely thin, about 0.025 mm. Usually it is only markedly thicker within the hilum along the raphe and at the tip of the radicle.

The endosperm lies under the seed coat and the embryo is completely immersed in it. The endosperm is thickest at the sides of the cotyledones, more or less at mid length of the seed (in its thickest part). At the tip and lateral edges of the cotyledones and at the radicle tip it is the thinnest. In these places in extreme cases an endosperm layer of 0.025-0.050 mm was noted, usually, however, it is somewhat thicker.

The embryo is large, straight with well developed cotyledones and a distinct radicle; it is flattened laterally like the seed. Exceptionally the embryo has a different position (Fig. 22). The cotyledones are of equal lenght, sometimes, however, their tips are not superposed, and then on the longitudinal section one of them seems longer (Figs. 16 and 36). A small triangular shoot growth apex is visible between the cotyledones. The radicle is straight, thick, often sharp at the tip. On sections a darker streak is visible running through the centre of the cotyledones and frequently also throught the radicle. The internal structure of the seeds gives no important features characteristic of the species. From each specimen 10 longitudinal and 10 cross sections of the seeds were prepared (Table 1 and drawings).

EXTERNAL STRUCTURE OF SEEDS

The hawthorn seeds are enclosed in thickwalled stones. The species growing in Poland either develop one stone or two. These stones when single are circular or oval on the cross section, their ventral part is convex, where as those from two-stone, fruits are semicircular and their ventral side is flat. The shape of the stones affects, of course, the shape of the seeds.

As a rule one seed develops in a stone, only sporadically (in *Crataegus monogyna* (4)) two normally developed seeds were found. Often, beside the fully developed seed in the stone cavity may be seen one or two wasted ovules (Figs. 6 and 7).

In the stones with normally developed seeds the cavity is spacious and its internal surface is smooth and shiny. On the ventral side of the stone there is a small opening through which the funiculus passes. Its arrangement on the seed varies and is characteristic of the species. The seeds are strongly flattened laterally, distinctly longer then wide, in side outline egg- or oval-shaped, oval or bent sicle-wise. The raphe well visible as a dark narrow strand runs from the free part of the funiculus towards the seed apex, along the ventral edge or just beside

Table 1

Dimensions of embryos and endosperm

Genus	Site	No. of stones in fruit	Embryo length (mm)		Cotyledon length (mm)		Cotyledon width (mm)		Cotyledon thickness (mm)		Radicle length (mm)		Maximum endospem thickness (mm)	
			minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum	minimum	maximum
Crataegus monogyna	4	1	4.20	4.90	3.55	3.85	2.95	3.15	0.45	0.55	0.65	1.05	0.325	0.400
	8	1	4.90	5.40	4.00	4.30	2.15	2.80	0.45	0.60	0.65	1.10	0.175	0.300
	9	1	4.90	5.10	3.90	4.25	2.40	2.75	0.35	0.50	0.75	1.05	0.250	0.325
Crataegus curvisepala	1	1	4.50	5.00	3.55	4.10	2.60	3.05	0.55	0.80	0.75	1.10	0.150	0.400
	5	1	5.25	6.05	4.30	4.50	2.50	2.90	0.40	0.60	0.90	1.75	0.200	0.300
	8	1	5.50	6.65	4.65	5.35	2.25	2.55	0.45	0.60	0.85	1.30	0.225	0.350
Crataegus lindmanii	7	1	4.50	4.85	3.45	3.70	2.20	2.60	0.55	0.60	0.90	1.25	0.175	0.300
	7	1	4.55	5.20	3.40	4.15	2.35	2.70	0.55	0.65	0.75	1.20	0.175	0.325
Crataegus oxyacantha	1	2	4.75	5.75	3.75	4.65	1.55	2.00	0.55	0.60	0.60	1.10	0.200	0.300
	3	2	4.35	5.20	3.90	4.50	1.65	2.05	0.50	0.60	0.45	0.95	0.150	0.300
	10	2	3.90	4.55	3.20	3.70	1.80	2.00	0.55	0.60	0.70	1.00	0.175	0.350
Crataegus palmstruchii	1	2	5.30	6.00	4.30	4.60	1.90	2.30	0.45	0.60	0.90	1.50	0.200	0.275
	6	2	4.85	5.45	4.00	4.40	1.65	1.85	0.30	0.35	0.85	1.15	0.250	0.300
Crataegus macrocarpa	2	1	5.20	5.80	3.50	4.50	2.75	3.00	0.45	0.55	1.30	1.70	0.225	0.300
	8	1	5.00	5.55	4.15	4.80	2.90	3.30	0.50	0.60	0.75	0.95	0.175	0.325

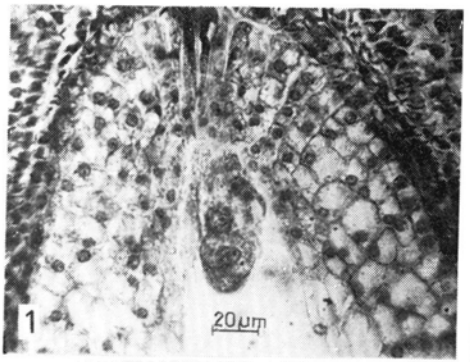
Data from 10 measurements.

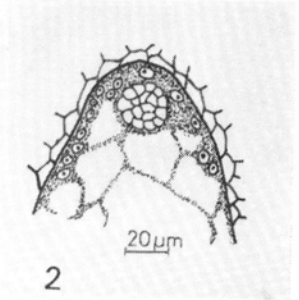
Table 2

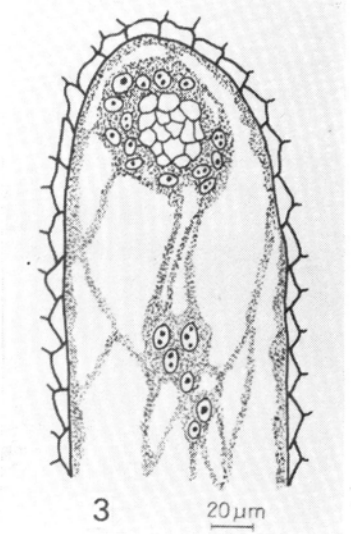
Seed dimensions

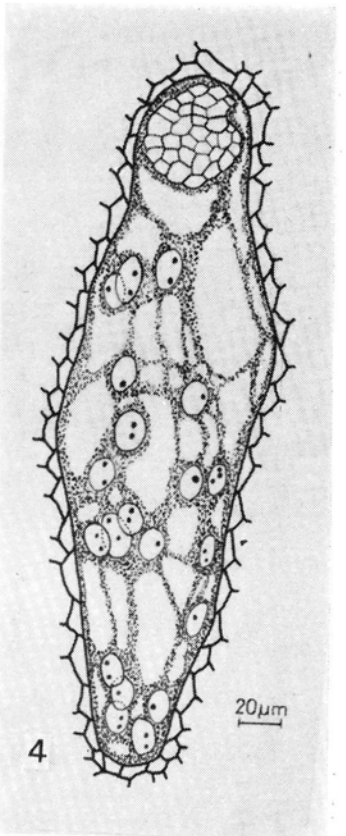
Genus	Site	No. of stones in fruit	Length (mm)			Width (mm)			Thickness (mm)			Mean ratio			Remarks
			minimum	maximum	mean	minimum	maximum	mean	minimum	maximum	mean	length/ width	length/ thickness	width/ thickness	
Crataegus monogyna	4	1	4.40	5.55	5.00	3.15	3.70	3.47	1.50	2.10	1.77	1.44	2.82	1.96	
	8	1	5.00	5.90	5.40	2.75	3.40	3.05	1.35	1.90	1.54	1.77	3.51	1.98	
	8	2	5.05	6.00	5.46	2.15	2.85	2.46	1.30	1.80	1.58	2.22	3.43	1.56	30 measurements
	9	1	4.80	6.00	5.43	2.50	3.35	3.08	1.40	1.80	1.63	1.76	3.33	1.89	
Crataegus curvisepala	1	1	4.80	6.35	5.52	2.95	3.75	3.29	1.50	2.00	1.77	1.68	3.12	1.86	
	5	1	5.85	6.95	6.47	2.65	3.55	3.15	1.30	2.00	1.65	2.05	3.19	1.91	
	8	1	5.75	7.10	6.45	2.60	3.25	2.95	1.20	1.95	1.58	2.21	4.08	1.85	
	8	2	5.85	7.25	6.56	1.95	2.75	2.29	1.35	1.90	1.66	2.86	3.95	1.38	30 measurements
Crataegus lindmanii	7	1	4.20	5.50	4.92	2.40	3.00	2.75	1.55	2.05	1.80	1.79	2.73	1.53	seeds of 2 bushes
	7	1	4.60	5.85	5.29	2.45	3.25	2.81	1.55	2.10	1.79	1.88	2.93	1.57	examined
Crataegus oxyacantha	1	2	5.15	6.25	5.59	1.80	2.45	2.09	1.05	1.75	1.54	2.67	3.63	1.36	
	3	2	4.00	5.70	4.95	1.75	2.50	2.15	1.50	1.95	1.75	2.30	2.83	1.26	
	10	2	4.00	5.00	4.49	1.80	2.50	2.10	1.25	1.90	1.63	2.14	2.75	1.29	
Crataegus palmstruchii	1	2	5.85	7.00	6.43	2.15	2.80	2.45	1.15	1.85	1.54	2.66	4.18	1.57	
	1	1	6.15	7.00	6.52	2.70	3.40	3.01	1.15	1.75	1.49	2.17	4.38	2.02	25 measurements
	6	2	5.35	6.50	6.02	1.75	2.55	2.27	0.90	2.15	1.36	2.65	4.43	1.67	
	6	1	4.85	6.15	5.62	2.50	3.15	2.80	0.90	1.65	1.23	2.08	4.57	2.28	25 measurements
Crataegus macrocarpa	2	1	5.75	6.90	6.32	2.65	3.60	3.21	1.20	1.95	1.64	1.97	3.85	1.96	
	8	1	5.65	7.10	6.40	2.90	4.00	3.55	1.35	1.95	1.63	1.80	3.93	2.18	

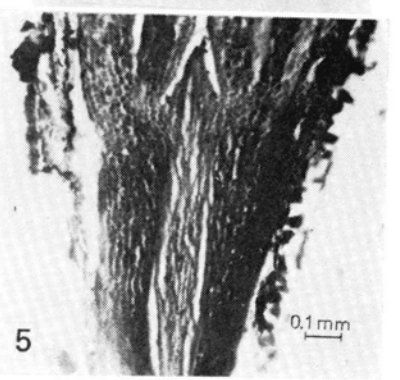
Data from 10 measurements.











Crataegus curvisepala Jacq., (site 2)

Fig. 1. Four-called embryo, around embryo sac nucellus cells

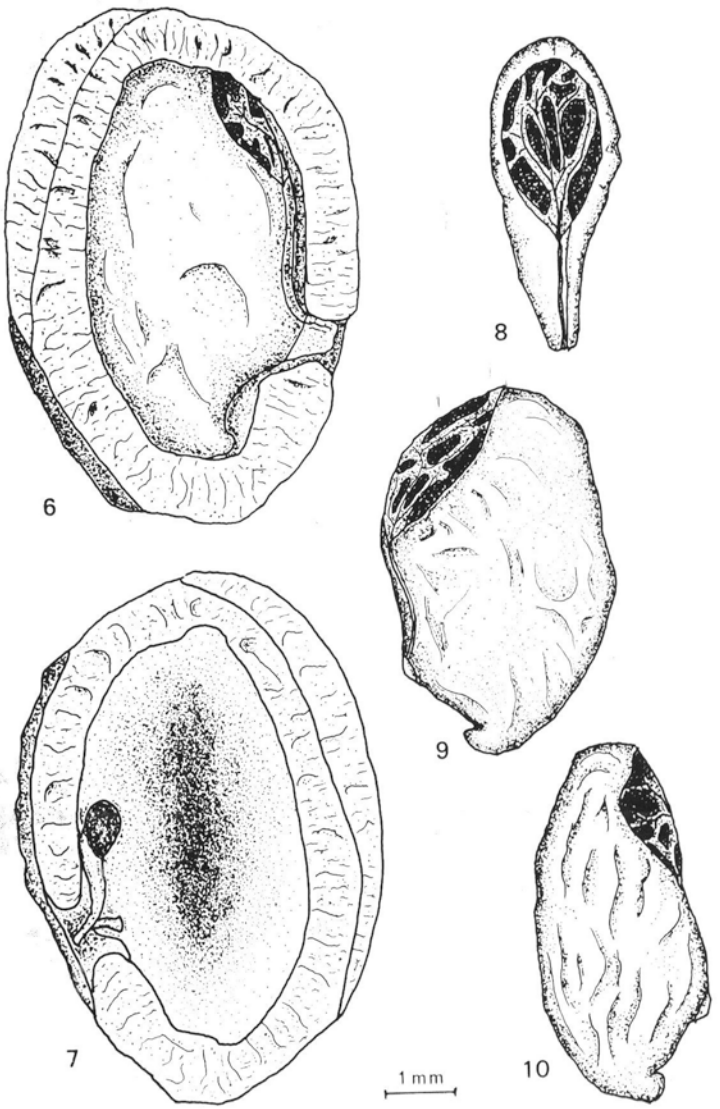
Fig. 2. Early stage of globular embryo, endosperm nuclei localised around embryo on micropylar pole

Fig. 3. Embryo in globular stage, endosperm nuclei around embryo and in central part of embryo sac

Fig. 4. Multicellular embryo, endosperm nuclei in central and chalazal part of embryo sac

Fig. 5. Growth apex of shoot with cotyledone bases and radicle of developed embryo

Plate II



Crataegus monogyna Jacq., (Figs. 6, 7 and 10 — site 9; Figs. 8 and 9 — site 4)
Fig. 6. Situation of seed in stone
Fig. 7. Second half of stone (from Fig. 6) wasted ovule visible
Fig. 8. Seed from hilum side
Fig. 9. Seed from one-stone fruit
Fig. 10. Seed from two-stone fruit

it. It reaches the hilum situated in the top part of the seed, frequently shifted to the ventral edge. The hilum lies somewhat asymmetrically on the side walls, in extreme cases it develops on one side wall (Figs. 18, 19, 27 and 28). The hilum surface is mat and covered with irregular dark brown or almost black spots. Between these a branched vasculatura is visible (vascular bundles). The situation of the hilum on the seed is a diagnostic feature of the species (Fig. 8).

Depending on the species, the lateral surfaces of the seeds are either smooth or irregularly folded, mat or shining, light brown. In high magnification (×50) a delicate minute relief of concavities and dots can be seen. In the lower part of the seed (on the embryonal radicle side) always distinctly narrowed, there develops in some species a hook-like process bent towards the funiculus or a tubercle leaning towards it.

Usually seeds from one-stone fruits are much broader than those from two-stone ones, even in the same plant specimen. The mean lenght-to-width ratio for the former is, depending on the species 1 to 2 (sporadically a little over 2) and for the latter these values are between 2 and 3. In spite of the rather high similarity of the seeds of the particular species, they have specific diagnostic features. The dimensions of the seeds are listed in Table 2.

Investigations on embryo and endosperm development in the Polish species of the genus *Crataegus* L. established that:

1) The embryo does not develop according to any of the types of embryogenesis known from the literature (Rodkiewicz 1973). The globular stage of the embryo persists a long time which is in agreement with the data of Radionenko (1963) and Czosnowski (1966).

2) In spite of simultaneous fertilization of the egg cell and the secondary nucleus, endosperm development precedes that of the embryo. The endosperm is nuclear, which Scharf (1931) and Davis (1966) consider this as a characteristic feature of the *Rosaceae* family.

3) The process of endosperm cellularization occurs in the period when the embryo differentiates. Storage proteins and lipids were found in the cells of both the endosperm and the embryo.

4) Mature seeds contain endosperm in which the large embryo is completely immersed. They may be described as poor in endosperm. This fact was not taken into account in Flora Europaea (vol. 2), Flora Polska (vol. 7) and by Szafer et al. (1953). In the characteristic of the subfamily *Maloideae* (=*Pomoideae*) in Flora Polska (page 242) it is said that the seeds are endospermless. However, preliminary investigations performed on seeds of other genera of this subfamily (*Malus, Pirus, Sorbus, Cydonia, Cotoneaster*) demonstrated also the presence of small amounts of endosperm.

5) The internal structure of the seeds shows no diagnostic features for the species.

6) The external structure of the seeds exhibits features characteristic of the species. They appear in the shape and size of the seeds, the location of the funiculus and hilum and the development of the side walls. These features in some species are similar so the determination of species according to them is not always certain.

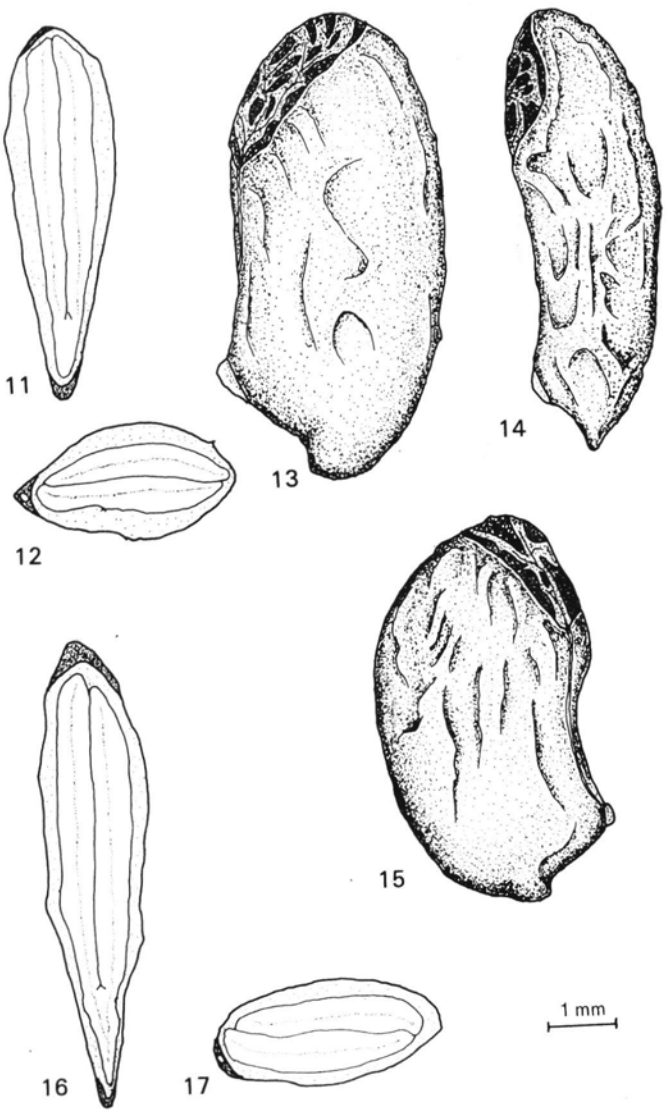
DETAILED DESCRIPTION OF SEEDS

Crataegus monogyna Jacq. — Fruits usually with one stone less frequently with two. Seeds stubby short but wide, in side outline oval or egg-shaped-oval, widest at mid lenght. Lateral surfaces slightly folded, mat or rather shiny. Hilum close to tip somewhat shifted to ventral edge, on side walls slightly asymmetric. Funiculus at 1/3 or 1/4 of seed length. Tubercle above radicle distinct, frequently with hook--like process (Figs. 9-12).
Variability: Seeds of two-stone fruits elongated, much narrower than the typical ones but somewhat longer, with strongly folded surface; entire hilum shifted to ventral edge. When seeds develop in stone sporadically the seeds are deformed. There are differences in length and width of seeds. The shortest and widest ones were those from site 4.
Site: 4 (aut.), 8 (B.), 9 (G.-J.).

Crataegus curvisepala Lindm. — As a rule fruits with one stone seldom with two. Seeds elongated, oval or slightly sickle-like bent. Dorsal edge convex arched, ventral edge more or less straight or concavely arched. Surface slightly folded, mat or a little shining; some seeds have one side almost smooth, somewhat shining, the other folded and mat. Hilum located close to tip, shifted towards ventral edge; its spots not very dark, brown, in some seeds their edge is diffuse. Funiculus situated on the convexity at 1/5-1/4 (1/3) of seeds length. Distinct tubercle above radicle, sometimes leaning towards the funiculus. Seed edge between radicle and funiculus usually straight (Figs. 13-17).
Variability: Seeds of the two stone fruits straight or slightly sickle-wise bent, more folded, hilum shifted to ventral edge. Funiculus close to radicle at 1/5 (or below) of seed length. Seeds from two-stone fruits somewhat longer then of the one-stone ones.
Seed length greatly varied, the shortest and widest ones originates from site 1, seeds from sites 5 and 8 are almost egual.
Site: 1 (aut.), 5 (aut.), 8 (B.).

Crataegus lindmanii Hrabět.-Uhr. — One-stone fruits. Seeds distinctly oval, widest at mid length. Side surfaces of seeds usually different; one side without folds, smooth, very shiny, the other strongly folded, in extreme cases the folds form a network with large irregular

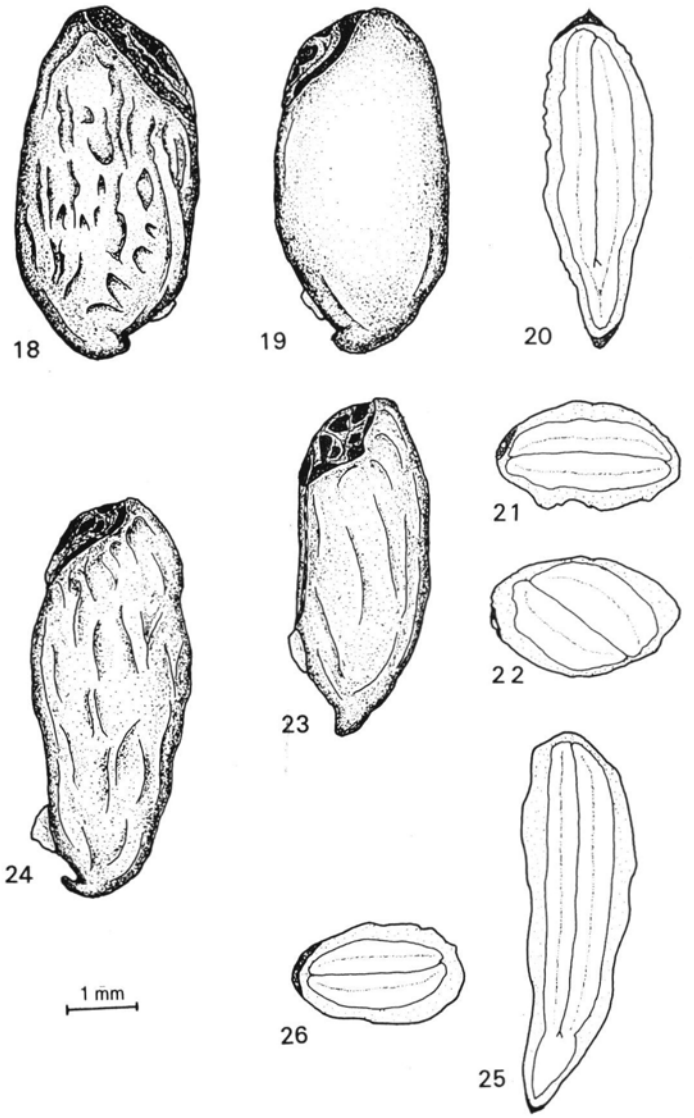
Plate III



Crataegus monogyna Jacq., (site 9): Fig. 11. Longitudinal section through seed Fig. 12. Cross section through seed

Crataegus curvisepala Jacq.: (Figs. 13 and 14 — site 8; Fig. 15 — site 1; Figs. 16 and 17 — site 5) Fig. 13. Seed from one-stone fruit. Fig. 14. Seed from two-stone fruit. Fig. 15. Seed from one-stone fruit. Fig. 16. Longitudinal section of seed. Fig. 17. Cross section of seed

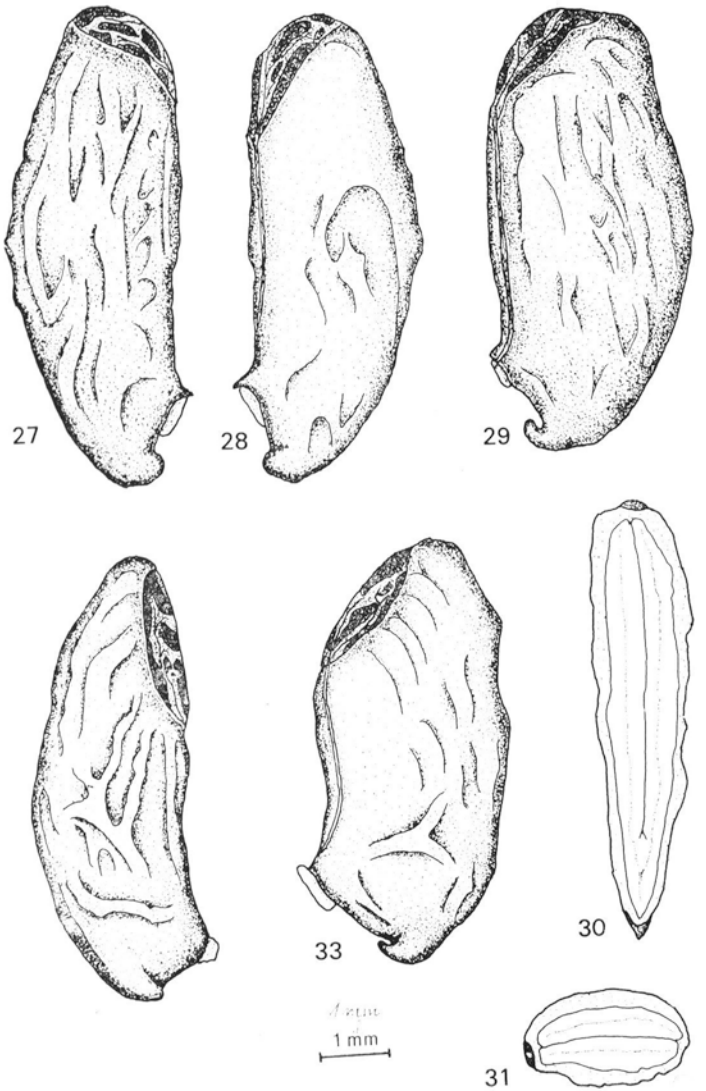
Plate IV



Crataegus Lindmanii Hrabět.-Uhr. (site 7): Figs. 18-19. Seed from one-stone fruit. Fig. 20. Longitudinal section of seed. Fig. 21. Cross section of seed. Fig. 22. Cross section of seed, abnormal position of embryo.

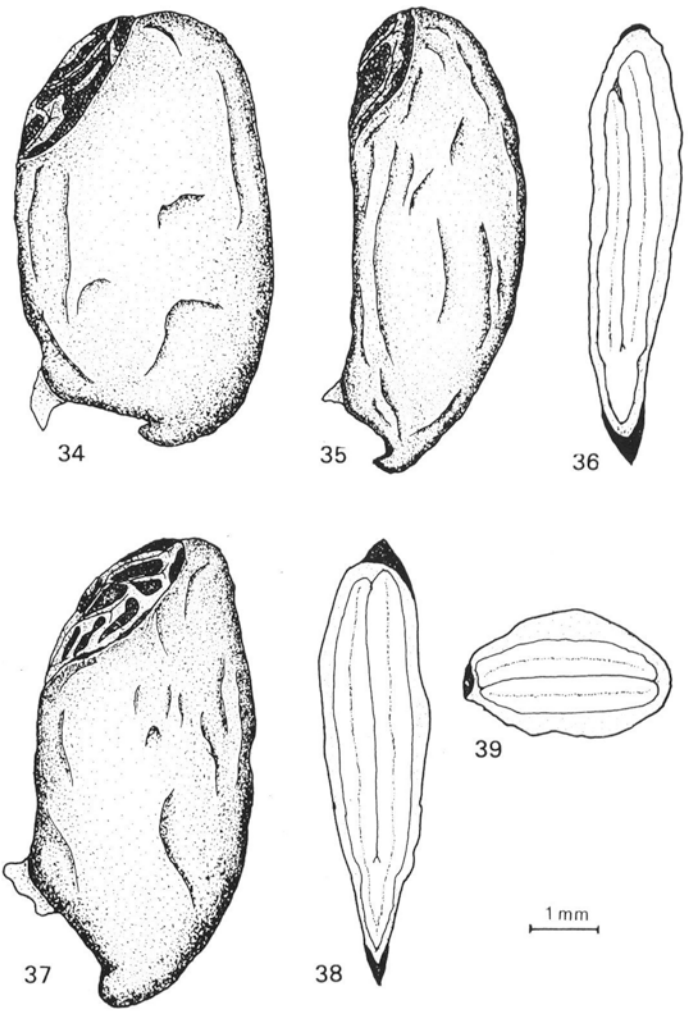
Crataegus oxyacantha L. em. Jacq. (Fig. 23 — site 10; Fig. 24 — site 1; Figs. 25 and 26 — site 3): Fig. 23. Seed from two-stone fruit. Fig. 24. Seed from two-stone fruit. Fig.25. Longitudinal section of seed. Fig. 26. Cross section of seed

Plate V



Crataegus palmstruchii Lindm. (Figs. 27-31 — site 1; Figs. 32-33 — site 6): Figs. 27-28. Seed from two-stone fruit. Fig. 29. Seed from one-stone fruit. Fig. 30. Longitudinal section of seed. Fig. 31. Cross section of seed. Fig. 32. Seed from two-stone fruit. Fig. 33. Seed from one-stone fruit

Plate VI



Crataegus macrocarpa Hegetsch. (Figs. 34-36 — site 8; Figs. 37-39 — site 2): Fig. 34. Seed from one-stone fruit. Fig. 35. Seed from two-stone fruit. Fig. 36. Longitudinal section of seed. Fig. 37. Seed from one-stone fruit. Fig. 38. Longitudinal section of seed. Fig. 39. Cross section of seed

eyes, mat. Hilum situated quite asymmetrically, its greater part usually on folded side. Spots on it dark brown, sometimes almost black, their centre somewhat lighter. The ventral edge without convexities, funiculus close to radicle at (1/6) 1/5-1/4 of seed length. Tubercle over radicle but little pronouced leaning towards funiculus (Figs. 18-22).
Site: 7 (G.-J.) material examined from two bushes.

Crataegus oxyacantha L. *em.* Jacq. — Two-stone fruits, sporadically one-stone. Seed shape variable from elongated to stubby. In side outline seed egg-shaped, distinctly elongated, widest and thickest frequently above mid length (ca. 3/4). Dorsal edge convexly arched, ventral edge concavely arched or less frequently straight; hence seeds sickle-wise bent. Lateral surfaces distinctly folded, folds not very prominent, mat, seldom slightly shining. Hilum large, usually occupies tip of seeds and is slightly shifted towards ventral edge, asymmetric, in extreme cases developed unilaterally. Spots on hilum dark brown. Funiculus situated in lower part of seed at 1/5-1/4 of length, rather wide, frequently on convexity. Tubercle above radicle distinct though small, usually hook--like curved (Figs. 23-25).
Variability: Some not numerous seeds stubby, seen from ventral side truncated at tip, in lower part narrowed wedge-like; their appearance and proportions resemble those of other species with one-stone fruits, although they developed in two-stone ones. Wide differences in seed length; the longest ones are from site 1, the shortest from site 10. The remaining dimensions are similar.
Site: 1 (aut.), 3 (aut.), 10 (G.-J.).

Crataegus palmstruchii Lindm. — As a rule two-stone fruits frequently however one-stone (ca 5-10%). Seeds from two-stone fruits greatly elongated, their dorsal edge arched convexly, ventral edge arched concavely or almost straight. Lateral surfaces usually differing: one more and deeper folded, mat, the other usually with few folds and rather shining. Hilum at tip or shifted to ventral edge; its spots black, spaces between them dark. Funiculus lies on convexity, low at 1/6-1/5 of seed length. Above radicle a distinct though small tubercle, leaning towards funiculus or frequently a hook (Figs. 27-31).
Variability: Seeds of one, stone pip fruits much broader, less folded. Hilum in seeds from site 1 usually at tip, from site 6 shifted towards ventral edge and frequently not reaching to tip. Seeds from site 1 longer and broader than those from site 6.
Site: 1 (aut.), 6 (aut.).

Crataegus macrocarpa Hegetsch. — One-stone sporadically two-stone fruits. Seeds large, oval or egg-shaped-oval. Dorsal edge convexly arched, ventral edge convexly arched or less freguently almost straight. Lateral surface equal, slightly and shallowly folded, mat. Hilum shifted towards ventral edge, yet, reaching tip, but does not comprise it, usually distinc-

tly asymmetric, in extreme cases unilateral. Funiculus situated on convexity at 1/5-1/4 (1/3) of seed length; the segment between funiculus and radicle almost straight. Tubercle above radicle prominent, learning towards funiculus or as often hook-shaped (Figs. 24-39).

Variability: Seeds of two-stone fruits elongated, their ventral edge straight, more folded, hilum shifted to ventral edge, funiculus close to radicle. Seeds from site 8 are more stubby, their funiculus as a rule situated lower as compared with that on seeds from site 2; seeds from site 2 somewhat longer and broader.

Site: 2 (G.-J.), 8 (B.).

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Rozwój i budowa nasion głogów (Crataegus L.) występujących w Polsce

Streszczenie

Zbadano budowę wewnętrzną i zewnętrzną nasion: *Crataegus monogyna* Jacq., *C. curvisepala* Lindm., *C. lindmanii* Hrabět.-Uhr., *C. oxyacantha* L. *em.* Jacq., *C. palmstruchii* Lindm., *C. macrocarpa* Hegetsch. Stwierdzono, że zarodek rozwija się w swoisty sposób a rozwój bielma wyprzedza rozwój zarodka. W dojrzałych nasionach przebadanych gatunków pod łupiną nasienną występuje bielmo a w nim zanurzony jest całkowicie zarodek o dużych liścieniach i korzonku. Wygląd zewnętrzny nasion poszczególnych gatunków jest różny i na tej podstawie można określić ich przynależność gatunkową.