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Morphology and stucture of wild apple (*Malus silvestris* Mill.). common pear (*Pyrus communis* L.) and *Chaenomeles japonica* (Thunb.) Lindl. seeds

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Abstract

The outer and inner structure of wild apple (*Malus silvestris* Mill.), common pear (*Pyrus communis* L.) and *Chaenomeles japonica* (Thunb.) Lindl. seeds was investigated. It was found that the outer structure exhibits good diagnostic features expressed in the first place in the relief of the seed coat and further in the arrangement and appearance of the site of attachment of the free end of the funiculus and the shape of the seeds. In ripe seeds there is, under the thick seed coat, an endosperm layer completely surrounding the embryo which has large cotyledons and a thick rootlet.

Key words: seeds, morphology, inner structure, Maloideae.

INTRODUCTION

Two of the studied species occur on natural sites in Poland — *Malus silvestris* Mill. and *Pyrus communis* L.; the third one closely related to the others, *Chaenomeles japonica* (Thunb.) Lindl. originates from East Asia and is frequently cultivated as an ornamental shrub. The apple and pear trees occupy similar habitats, they grow on edges of forests and brushwood and on balks among fields. Both species exhibit a high variability of specific traits (Flora Polska vol. 7, 1955); in the fruits this variablity is manifested in their shape and colour.

The taxonomic position of the studied species is as follows: familia *Rosaceae*, subfamilia *Maloideae (=Pomoideae)* tribus *Maleae*, according to Engler (1964). For identification of the specimens from which the seeds were collected keys and descriptions were applied from the works of Szafer et al. (1953), Kościelny and Sękowski (1971).

The present paper is a continuation of investigations on the morphology of seeds of species from the subfamily *Maloideae*. The earlier paper dealt with the seed structure in the genus *Crataegus* L. (P e l c and P t a k 1981). Further studies will concern seeds of species from the genera *Sorbus* and *Cotoneaster*.

MATERIAL AND METHODS

From each tree specimen 50 seeds were taken from ripe fruits stored in dry conditions, and their length, breadth and thickness were measured under an MBS-2 microscope at a × 16 magnification (with an accuracy up to 0.05 mm) and in a × 32 magnification (accuracy up to 0.025 mm). The drawings were made with the use of an MNR-1, PZO drawing apparatus. The relief of the seed coat was photographed in a scanning microscope.

The seeds were transected at three levels: along the long seed axis in the planes parallel and perpendicular to the flattening and across the long axis in the widest place, usually somewhat above mid length (closer to the hilum).

Tissue from the endosperm and embryo was examined for the presence of storage material belonging to basic chemical groups. Sections from the embryo cotyledons were free-hand prepared for microscopic examination. The endosperm layer was separated from the seed coat under a stereoscopic microscope and examined in preparations without making sections. The small thickness of the endosperm in the seeds of the studied species allows this type of observation. Material for detection of simple sugars was ground separately from the embryo and from the endosperm in a small glass mortar and extracted with distilled water. For revealing storage materials the following reagents were used: for simple sugars Fehling's reagent, for starch — Lugol, for hemicellulose — PAS, for proteins Millon's reagent and for lipids — Sudan III.

The material for study was collected from the following localities: *Malus silvestris* Mill. from: 1) Tuł (a mountain 621 m a.s.l.) Cieszyn Foothills, 2) Zbydniów, Tarnobrzeg District, 3) Klęczany, Rzeszów District, 4) Kalników, commune Stubna, Przemyśl District (seeds collected from two specimens further referred to as Kalników I and II).

Pyrus communis L.: from 1) Chęciny, Góra Zamkowa Mt., Kielce District, 2) Bratkowice, Rzeszów District, 3) Kalników, commune Stubna, Przemyśl District.

Chaenomeles japonica (Thunb.) Lindl. from: 1) Kraków-Łęg (city district) from garden.

Table 1

Dimensions of seeds (mm)

Species Locality	Length				Breadth				Thickness				Mean ratio			Remarks
	min.	max.	mean	±S.D.	min.	max.	mean	±S.D.	min.	max.	mean	±S.D.	length/ breadth	length/ thickn.	breadth/ thickn.	
Malus silvestris:																
Tuł	5.45	7.50	6.57	0.50	3.25	4.75	4.14	0.35	1.75	3.05	2.34	0.24	1.59	2.81	1.77	
Zbydniów	6.30	7.75	6.83	0.44	3.85	4.65	4.28	0.20	1.90	2.50	2.18	0.15	1.60	3.13	1.96	21 seeds
Klęczany	6.65	9.80	7.75	0.57	3.50	4.75	4.18	0.27	1.75	2.75	2.22	0.23	1.85	3.49	1.88	
Kalników II	5.50	7.50	6.34	0.49	3.35	4.25	3.74	0.20	2.25	2.95	2.65	0.17	1.70	2.39	1.41	
Kalników I	6.65	9.70	8.20	0.70	3.70	4.85	4.27	0.32	2.00	2.65	2.37	0.18	1.92	3.46	1.80	23 seeds
Pyrus communis:																
Chęciny	5.20	6.35	5.69	0.27	3.10	4.25	3.83	0.27	1.50	2.95	2.18	0.34	1.49	2.61	1.76	
Bratkowice	6.50	7.25	6.88	0.20	3.25	4.65	4.02	0.37	1.50	2.85	2.14	0.39	1.70	3.21	1.88	
Kalników	6.25	8.65	7.85	0.54	3.70	5.50	4.65	0.36	1.50	3.15	2.45	0.40	1.69	3.20	1.90	
Chaenomeles japonica:																
Kraków-Łęg	5.00	6.85	6.06	0.45	4.00	5.05	4.45	0.29	2.25	3.65	2.83	0.31	1.36	2.14	1.57	

Data from 50 measurements.

RESULTS

SEED MORPHOLOGY

The three species studied have induvial fruits. According to Troll (1957), the fruit proper consists of husky formations surrounding the loculi, while the whole parenchyma is derived from the fleshy receptacle. In normally developed fruits there are always five loculi. Numerous anatropic ovules develop on the placenta (Flora Europaea 1968) and the shape of the seeds depends on whether two or more neighbouring ovules develop. Seeds developing in the neighbourhood of others have one flat or concave wall while the other one is convex (Figs. 6, 13). When there is a single ovule, both lateral walls are convex (Fig. 12).

Seeds in the three species in point have the same type of construction, there are, however, individual diagnostic features on the basis of which their distinction is not difficult. The side outline of the seeds is as a rule obovate, and the widest part falls between 2/3 and 3/4 of the length, counting from the point of attachment. The length-to-breadth ratio in the seeds of the particular species is similar (Table 1). The seed shape is characteristic for each of the studied species. In the pear seeds the base is greatly elongated, frequently bent towards the ventral edge (Figs. 7, 8). In apple seeds the base is stil more stocky, less stretched and the site of attachment is wide and frequently surrounded by a fold of the seed coat (Figs. 1, 2). In *Chaenomeles* the seeds are much wider and their basal part is oval (Fig. 14).

The hilum is localized at the tip the seed asymmetrically, in some few cases on one of the lateral walls. It is poorly visible, frequently not differing in colour from the rest of the seed coat. On apple seeds it is least pronounced, sometimes in the form of a slight tuberosity, on pear seeds it is visible as a small tuberosity sometimes somewhat darker (Fig. 8). On *Chaenomeles* seeds it is darker and rather distinctly delineated (Fig. 14).

The part of the funiculus running along the ventral edge from the site of attachment to the hilum (visible on cross sections) is not as a rule noticeable and does not form a distinct raphe (Fig. 6). The site of attachment of the free part of the funiculus to the seed is characteristic for particular species; it is frequently shifted to the ventral edge (Figs. 1, 2, 7, 8). On apple seeds there usually appears a fold formed by the seed coat and surrounding pit-like cavities (Figs. 2, 3). In the pear seed the site of attachment is also caved in, but without a distinct fold (Figs. 7, 8), while in *Chaenomeles* it is nearly always situated at the tip of the sharp seed ending in a pit-like depression (Fig. 17).

The relief of the seed surface is very characteristic and is a useful diagnostic feature (Figs. 19-24). In the apple seed there are greatly elon-

gated fusiform papillae arranged along the long axis of the seed, in the pear seed the sculpture is pitted-punctuated and in *Chaenomeles* it is delicate, less pronounced and consists of a net with hexagonal mesh, elongated parallelly to the long axis of the seed.

The colour of the seeds is also characteristic: that of apple seeds is solid, light brown to brown with a slight grey deposit. In the microscope brown spots can be seen on a brownish-grey background, the seeds are mat. Pear seeds are dark brown, almost black, mat, in *Chaenomeles* they are light brown with a chestnut hue and markedly shiny.

The results of measurement and variability are shown in Table 1 and Figs. 25-27.

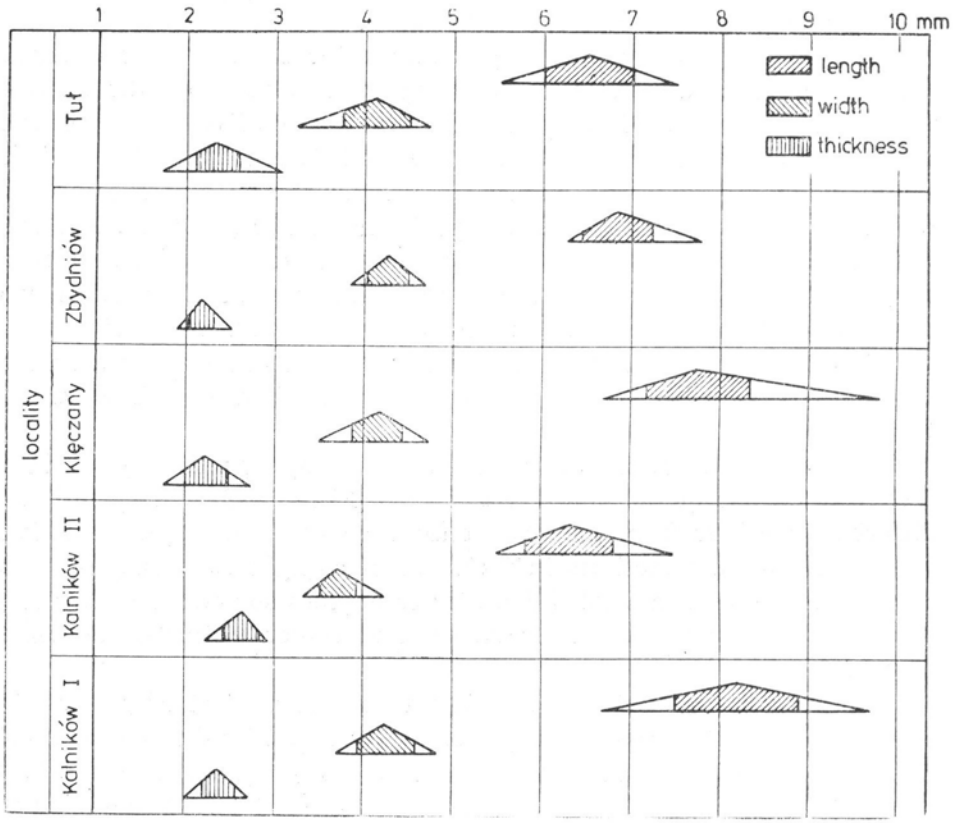
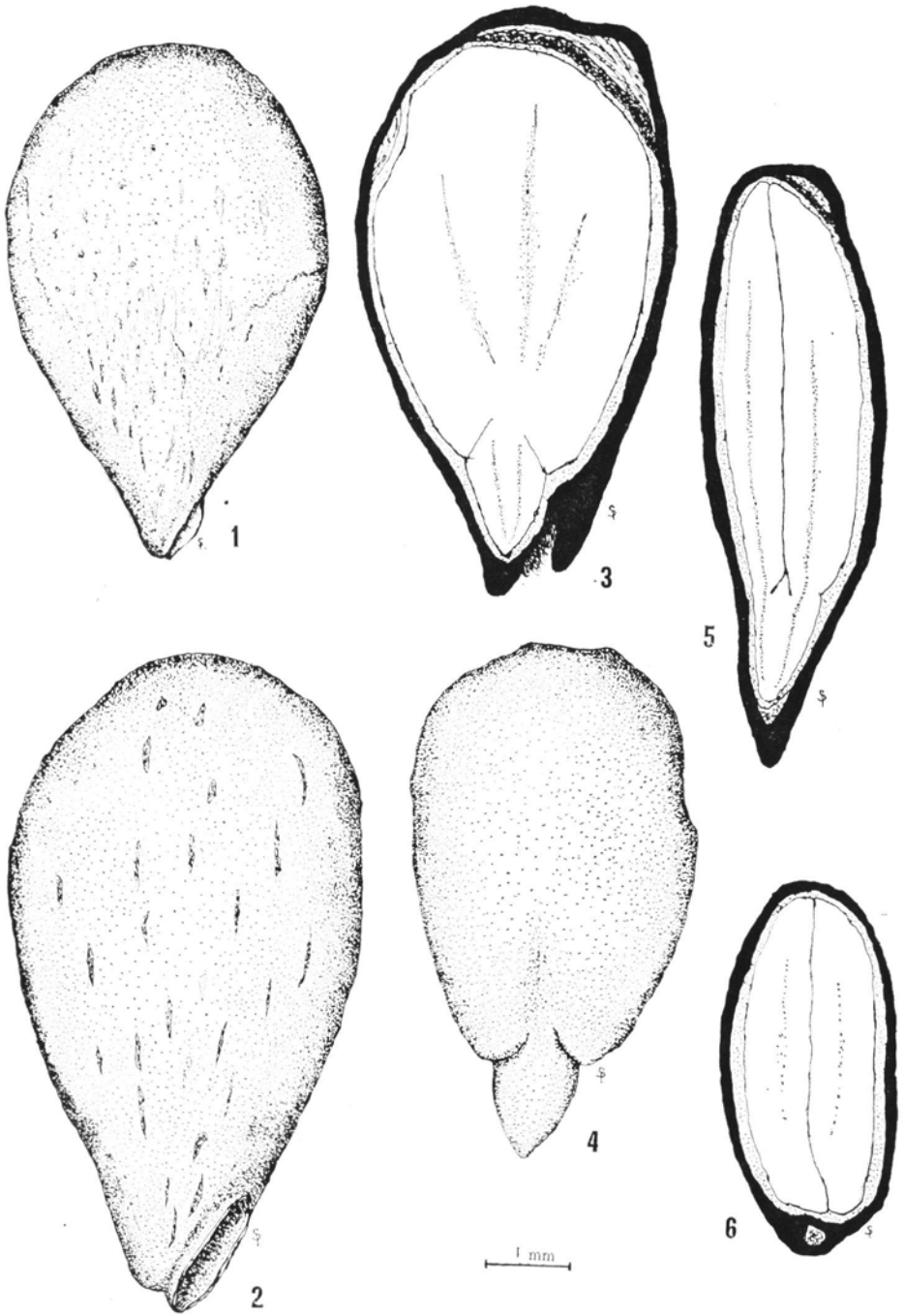


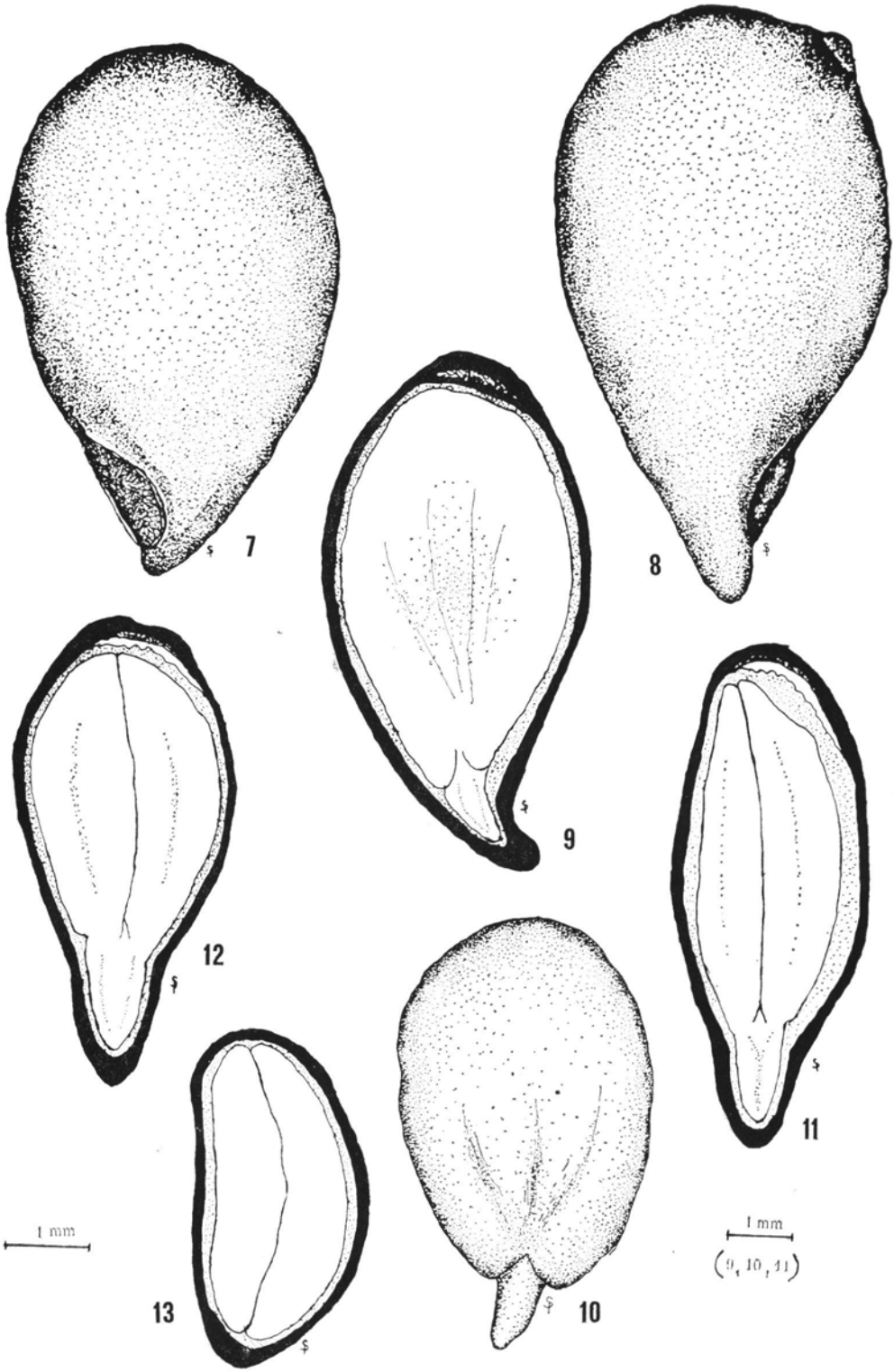
Fig. 25. Variability of *Malus silvestris* Mill. seed dimensions. The triangle vertex denotes the arithmetic mean; the shaded area — ± standard deviation

SEED STRUCTURE

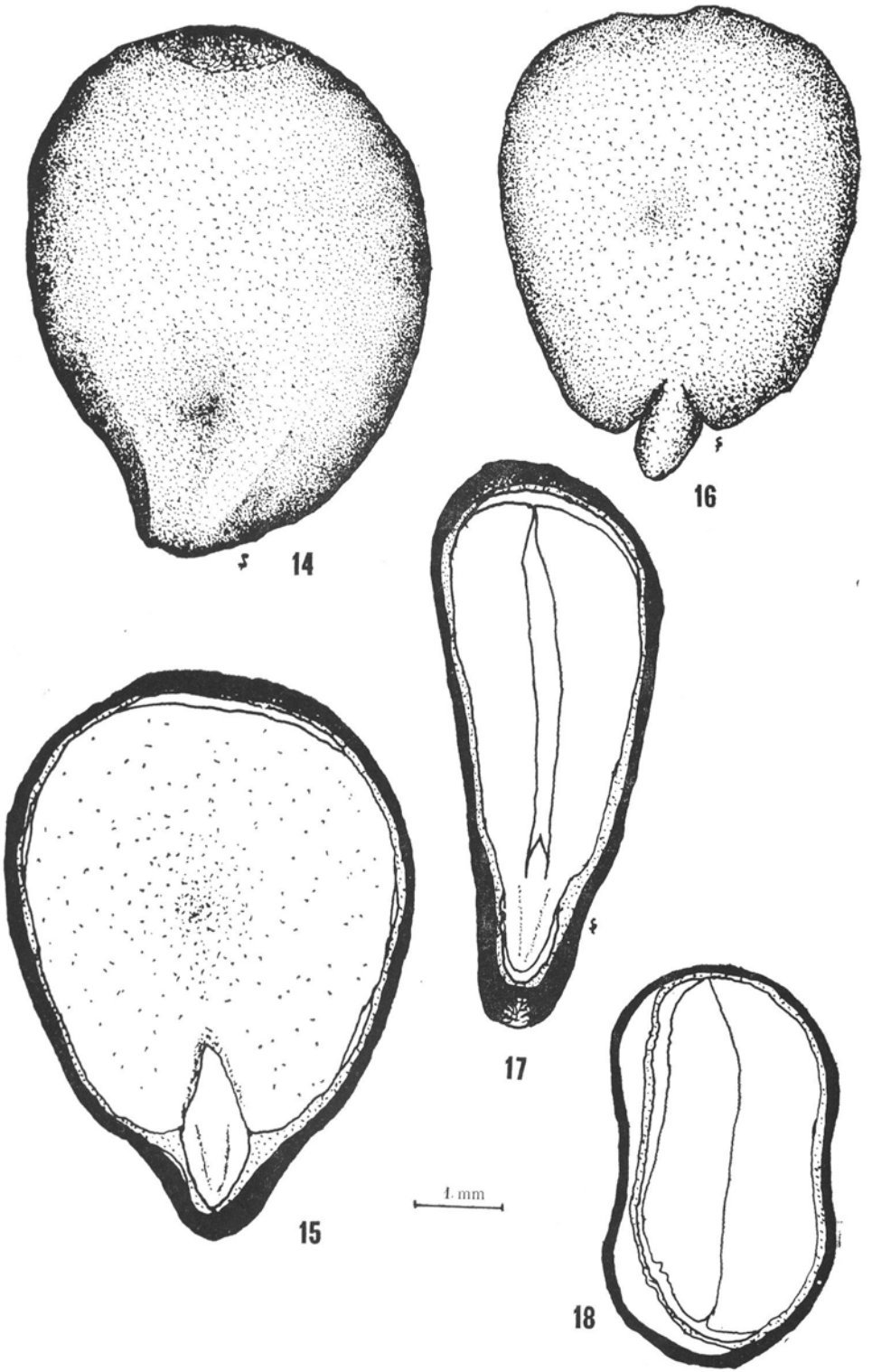
The seeds of the three studied species do not show major differences in their external structure. They are covered by a thick seed coat, varying at the sides of the cotyledons in thickness from 0.075 to 0.175 mm (Table



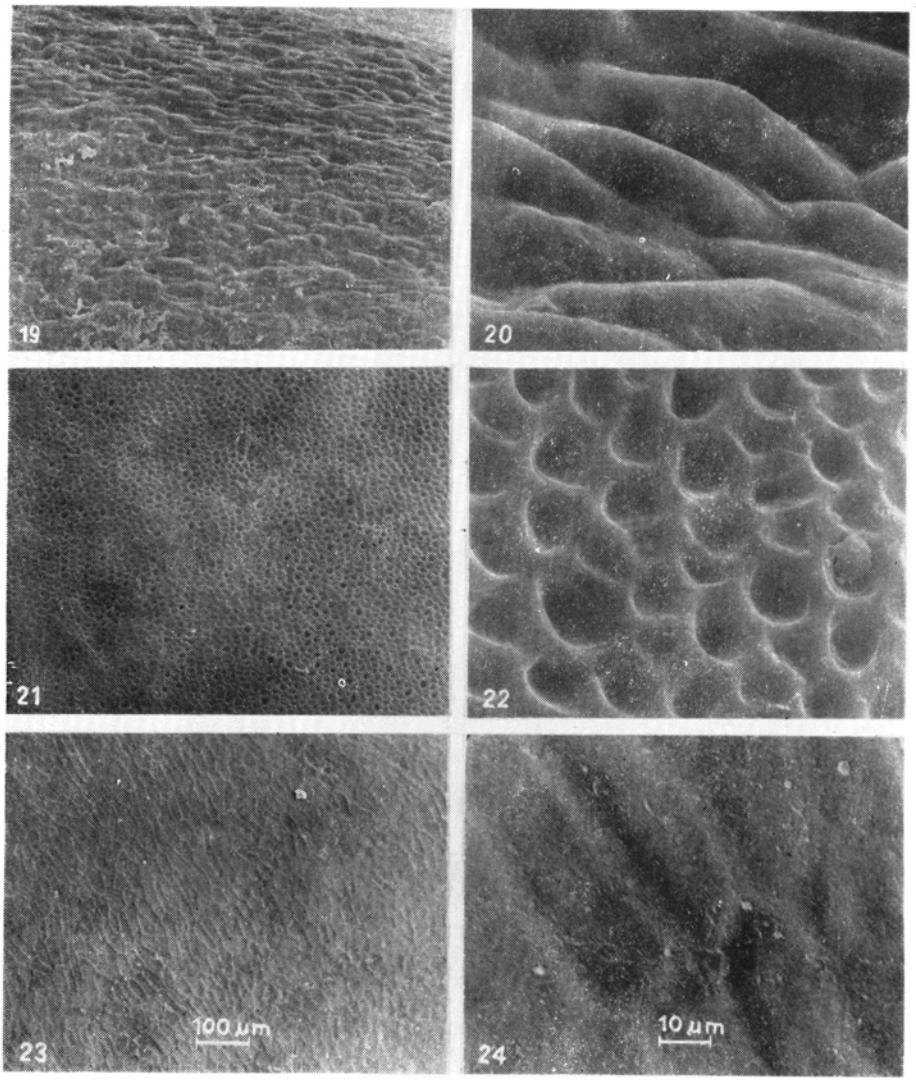
Figs. 1-6. *Malus silvestris* Mill.: Figs. 1, 2 — seed habit, Fig. 3 — longitudinal section through seed parallel to flattening. Fig. 4 — embryo (from seed in Fig. 3); Fig. 5 — longitudinal section of seed perpendicular to flattening; Fig. 6 — seed cross section. Figs. 1, 5, 6 — Tuł, Figs. 2-4 — Zbydniów



Figs. 7-13. *Pyrus communis* L.: Figs. 7, 8 — seed habit, Fig. 9 — longitudinal section of seed parallel to flattening; Fig. 10 — embryo (from seed in Fig. 9); Figs. 11, 12 — longitudinal sections of seeds, perpendicular to flattening; Fig. 13 — seed cross section. Figs. 7, 12, 13 — Chęciny, Fig. 8 — Bratkowice, Figs. 9-11 — Kalników



Figs. 14-18. *Chaenomeles japonica* (Thunb.) Lindl.: Fig. 14 — seed habit; Fig. 15 — longitudinal section of seed parallel to flattening; Fig. 16 — embryo (from seed in Fig. 15); Fig. 17 — longitudinal seed section perpendicular to flattening; Fig. 18 — cross section of seed. Figs. 14-18 — Kraków-Łęg



Figs. 19-24. Relief of seed coat surface: Figs. 19, 20 — *Malus silvestris* Mill. (Tuł); Figs. 21, 22 — *Pyrus communis* L. (Chęciny); Figs. 23, 24 — *Chaenomeles japonica* (Thunb.) Lindl. (Kraków-Łęg). For Figs. 19, 21, 23 — 100- µm segment marked, for Figs. 20, 22, 24 — 10 µm

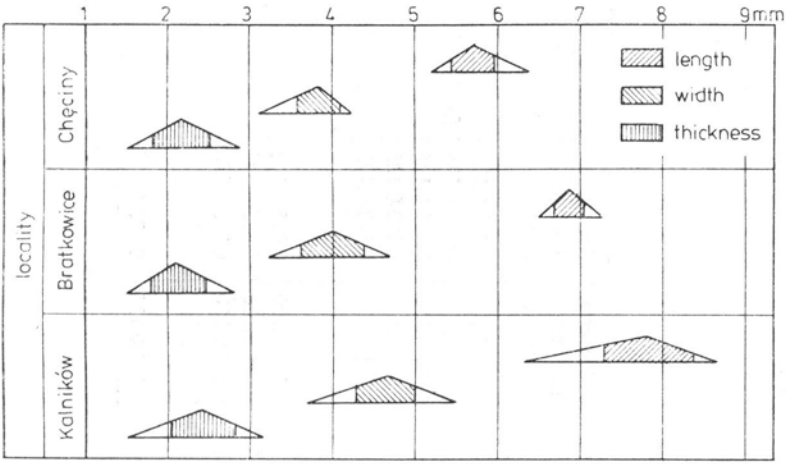


Fig. 26. Variability of seed dimensions of *Pyrus communis* L. Notations as in Fig. 25

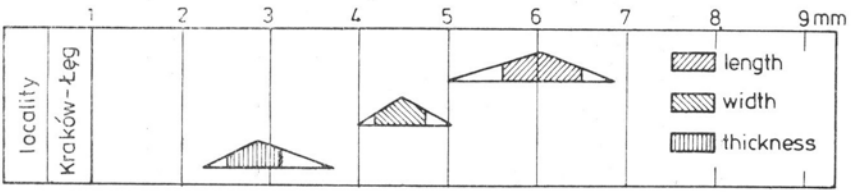


Fig. 27. Variability of *Chaenomeles japonica* (Thunb.) Lindl. seed dimensions. Notations as in Fig. 25

2). This coat is practically composed of one layer (seen in × 50 magnification), it is double-layered only within the hilum. The outer layer has a compact structure and the inner one is looser. Between these layers there is usually a smaller or larger space frequently filled with loose spongy tissue of much lighter colour or this space is empty (Figs. 3, 5, 9). The coat around the radicle is also much thicker, and thinner only at the site of attachment of the free part of the funiculus (Figs. 3, 17). At the ventral edge a thickening is frequently observed and a trace is visible left by the vascular bundle connecting the site of attachment with the hilum (cross sections, Figs. 6, 13).

The endosperm layer is thin (Table 2) ranging from 0.025 (sometimes less) to 0.175 mm (exceptionally more; 0.350 mm in *Pyrus communis* — Kalników). The measurements were taken at the sites where the endosperm was the thickest, that is at the sides of the cotyledons on the longitudinal section perpendicular to the flattening of the seed. At the cotyledon edges under the hilum and around the radicle the endosperm layer is thin, seldom exceeding 0.025 mm. Nevertheless the interior of the seed is lined with an endosperm layer and the embryo is surrounded by it.

Table 2

Dimensions of embryo, endosperm and seed coat (mm)

Species, Locality	Embryo length	Length of cotyledons	Breadth of cotyledons	Thickness of cotyledons	Radicle length	Endosperm thickness	Seed coat thickness	Remarks
Malus silvestris:								
Tuł	5.40-6.25	4.45-5.20	3.55-4.05	0.75-1.00	0.85-1.20	0.025-1.175	0.075-0.125	
Zbydniów	5.55-6.70	4.50-4.75	3.55-4.15	0.75-1.05	1.00-1.20	0.025-0.125	0.075-0.125	for 5 seeds
Klęczany	5.55-6.35	4.50-5.40	3.55-3.90	0.75-0.90	0.95-1.30	0.025-0.150	0.100-0.125	
Kalników II	4.35-5.50	3.30-4.40	3.25-3.65	0.85-1.05	1.05-1.35	0.025-0.150	0.100-0.125	
Kalników I	5.60-6.55	4.80-5.20	3.25-4.00	0.60-0.90	0.95-1.45	0.025-0.125	0.100-0.175	for 5 seeds
Pyrus communis:								
Chęciny	4.25-5.00	3.30-3.90	3.15-3.85	0.65-1.00	0.95-1.25	0.025-0.100	0.075-0.100	
Bratkowice	5.65-5.90	4.45-5.05	3.25-4.15	0.75-1.15	0.75-1.10	0.025-0.175	0.075-0.175	
Kalników	6.55-7.35	4.80-5.90	3.70-4.50	0.60-1.15	1.45-1.60	0.075-0.350	0.075-0.125	
Chaenomeles japonica:								
Kraków-Łęg	4.40-5.80	3.55-4.45	3.50-4.45	0.60-1.00	0.85-1.15	0.015-0.125	0.075-0.125	

Minimal and maximal values are given from 10 measurements.

The embryos of the examined species fill, together with the endosperm, almost the whole of the seed coat, but in some cases (e. g. in *Malus silvestris* — Kalników II, *Chaenomeles japonica* — Kraków-Łęg) there are free spaces in the seeds between the cotyledons, between the embryo and the endosperm or even between the endosperm and the seed coat. It is possible that this is an artefact caused by dehydration of the seeds during drying. The embryos are straight with thick cotyledons and usually with a straight radicle (Figs. 4, 10, 16). In some cases in pear seeds the base is bent towards the ventral edge and then the radicle is slightly turned up and does not lie on the long axis of the cotyledons (Fig. 9). A small growth apex of the shoot is visible between the cotyledons. Sometimes there are darker strands in the cotyledons and radicle. The whole embryo can easily be isolated from the endosperm.

From each examined specimen 10 cross sections were made in three planes. The results of study and measurements are listed in Table 2 and shown in the figures.

STORAGE MATERIALS IN THE SEEDS

The results of chemical investigations for the presence of storage material in the endosperm and cotyledons of the embryo are shown in Table 3.

Table 3

Distribution of storage materials in embryo and endosperm

Species	Part of seed	Simple sugars	Starch	Proteins	Lipids
Malus	embryo	−	−	+	+
silvestris	endosperm	−	+	+	+
Pyrus	embryo	−	−	+	+
communis	endosperm	−	+	+	+
Chaenomeles	embryo	−	+	+	+
japonica	endosperm	−	+	+	+

+ = present, − = absent

Starch is present in the form of small single grains, a dozen or so or several score in one cell. Subject to the plant species the diametre of the grains varies from 2.5 to 5.0 μm. The distribution of the grains is as follows: in *Malus silvestris* (in the endosperm) 30-40 starch grains are more or less uniformly distributed throughout the cell; the pattern is similar in *Pyrus communis*, but the starch grains are more numerous (ca. 40-60); in *Chaenomeles* seeds the grains are somewhat smaller and agglomerated (2-4), but they are not compound grains, there are about 20-30 in one cell. In the cotyledons of the above-cited plant there are

single spherical grains, a dozen or so in one cell (10-20). The cell walls both in the endosperm and cotyledons show distinct thickenings. In the PAS reaction the secondary cell walls stain red, thus indicating the presence of polysaccharides, probably hemicellulose; the thickenings in the endosperm are not regular.

Reserve proteins appear in all the examined species in the cells in the form of typical aleurone grains, several in each cell.

Lipids are present in the form of droplets of various size within the cell. Frequently at the edge of the section the lipid flows out beyond the tissue, owing to its damage, forming larger drops at the edge.

DETAILED DESCRIPTION OF SEEDS

MALUS SILVESTRIS MILL.

Seeds in lateral outline oblongly obovate, their apical part cylindrical, the basal part wedge-like sharp. Laterally flattened, both side walls convex or one more flattened. Sometimes, owing to the pressure of neighbouring seeds, there develops an additional edge in the lower part of the lateral wall. Relief of the seed coat in the form of greatly elongated fusiform papillae arranged along the long axis of the seed (magn. × × 25. Macroscopically the seed colour is solid, light brown to brown (never black). Under the microscope (× 25) chestnut brown small dots are visible (ca. 0.100-0.125 mm in dia.) against a shining brown-grey background. In some places these dots coalesce to form irregular larger spots, frequently elongated parallelly to the long seed axis. The hilum lies in the apical part, it is poorly visible and only slightly darker than the remaining surface, sometimes it is raised like a tubercle, frequently shifted towards the ventral edge, seldom completely on the lateral wall. The site of attachment of the funiculus is well visible, fusiform-oval, pit-like depressed, surrounded by a fold of the seed coat. It lies at the very tip of the sharp seed ending on the ventral edge. In the pit there are often light brown, yellow or whitish shreds. The vascular bundle joining the site of attachment of the funiculus with the hilum is not visible on the surface.

The embryo with the endosperm fills almost the whole seed coat. It is straight with thick cotyledons and a straight short radicle. The cotyledons are always of the same size, in the case of a flat-convex seed they may differ in thickness. The growth apex of the shoot is triangular on cross section. Sometimes, within the cotyledons and radicle darker strands are visible.

Endosperm is scarce, but it surrounds the embryo completely. It is the thickest at the sides of the cotyledons and thin at their edges and at the tip of the radicle and around it.

Seed coat thick and hard, formed of one layer. Within the hilum it is thicker (ca. 0.250-0.275 mm) and double-layered. Between the outer and the inner layer there is as a rule a space filled with loose spongy tissue light brown or yellowish in colour. On the inner side, under the hilum a brown-coloured, delineated oval spot is distinctly visible. The seed coat is also thickened around the radicle, and much thinner at the site of attachment of the funiculus.

Variability: Seeds from the localities of Klęczany and Kalników I are markedly longer, other dimensions differ but little. From the site in Klęczany they are brown with a chestnut hue, others are dark brown with a grey shade. In seeds from Kalników II the embryo frequently does not fill the seed coat. The mature fruits are slightly elongated or spherical, green-celadon with a yellow shade (Tuł, Klęczany, Kalników II) or with a red flush against a yellow background (Zbydniów, Kalników I).

Results of measurements: The outer dimensions of the seeds are listed in Table 1. Table 2 gives the dimensions of the embryo, endosperm and seed coat (Fig. 25).

Variability of outer dimensions is shown in Figs. 1-6 and 19-20, 25.

PYRUS COMMUNIS L.

Seeds in lateral outline elongated ovate, widest at 2/3 to 3/4 of length (from base). In side view distinctly flattened, usually one side flat the other convex, both walls are seldom convex. Apex oval, base sharp and stretched. Hilum at apex, usually shifted somewhat towards ventral edge, but little pronounced, sometimes only visible as a small somewhat darker tubercle. Trace of funiculus lies in the basal part and is shifted to the ventral edge, it is always lighter and lies in a small oval depression. Surface minutely but distinctly pitted-punctuated (magn. × 25) of dark brown almost black colour.

The embryo with endosperm fills almost completely the seed coat, sometimes, however, there is a free space under the hilum or, less frequently, at the edges. Embryo straight with thick cotyledons, straight and thick radicle; exceptionally the radicle is somewhat turned up towards the ventral edge. Within the cotyledons and radicle are visible sometimes not very distinct darker strands.

Endosperm is scarce, although it completely surrounds the embryo. It is the thickest at the sides of the cotyledons and the thinnest, sometimes below 0.025 mm thick at the edges and round the radicle.

Seed coat thick, brown-black and with the exception of the hilum, it consists of one layer. Within the hilum it is thicker and double-layered. The outer layer is brown-black and the inner one brown, between them there is looser tissue with spongy structure. On the inner side under the

hilum there is a brown spot. On the ventral edge the seed coat is thicker and sometimes a trace of the vascular bundle joining the site of attachment of the funiculus with the hilum is visible (on cross section). The seed coat round the radicle is also much thicker.

Variability: The seeds from Kalników were the largest, in shape they differed but little from the remaining ones. The hilum on them is distinct, tubercular, the basal part is turned up towards the ventral edge and therefore the radicle is slightly turned up. Seeds from Bratkowice brown, from the remaining localities brown-black or almost black. Ripe fruits small, dark green, spherical, on long stalks (Chęciny) or pear--shaped and somewhat larger on short stalks (Bratkowice, Kalników).
Results of measurements: Outer dimensions of seeds, see Table 1.
Dimensions of embryo, endosperm and seed coat — Table 2,
Variability of outer dimensions — Figs. 7-13, 21-22, 26.

CHAENOMELES JAPONICA (THUNB.) LINDL.

Seeds in lateral outline diverse — from widely obovate (almost cordate) to wedge-shaped with broad apical part, frequently asymmetric. Apical part widely cylindrical, basal part as a rule tapering wedge-like. Seeds laterally flattened, one wall convex the other flat or concave. Dorsal and ventral edges little pronounced. Some seeds have in their lower part on the lateral walls an additional edge running from the base to more or less 1/2 (or 2/3) of their height. Surface relief delicate consisting of net with hexa- or pentagonal meshes, elongated parallelly to long axis of seed (magn. × 50). Seed colour light brown with a distinct chestnut hue, markedly shiny. The hilum lies apically, it is circular or oval, darker (brown) than the rest of the seed coat, frequently distinctly delineated. The site of attachment of the funiculus lies at the sharp ending of the seed, it is small circular or slightly oval, pit-like depressed. At its edge light brown or whitish shreds. The vascular bundle joining the site of attachment with the hilum is well visible on the surface in most seeds in the form of a dark strand, better visible on the inner side (after removal of the embryo) as a light strand. This vascular bundle is as a rule shifted to one of the lateral walls, nevertheless it is localised close to the ventral edge.

The embryo with the endosperm does not fill completely the seed coat. It is straight with thick cotyledons and a short cylindrical radicle (never sharp-ended). Growth apex triangular on cross section, small.

Endosperm scarce, but surrounds the embryo completely. Thickest at sides of cotyledons, thinnest at their edges and at top.

Seed coat thick and hard (crumbles readily when cut), composed of one layer and only within the hilum double-layered. There is no distinct

space between the outer and the inner layers only sometimes a little pronounced cleft. From the inner side, under the hilum, a dark brown circular or oval spot is visible on the seed coat. Around the radicle the coat is much thicker, only at the site of attachment of the funiculus thinner. Ripe fruits spherical, usually with five longitudinal furrows, on very short stalks, celadon-coloured, aromatic.

Results of measurements: Outer dimensions — see Table 1.
Dimensions of embryo, endosperm, and seed coat — see Table 2.
Variability of outer dimensions — Figs. 14-18, 23-24, 27.

DISCUSSION

The seeds of all the studied species contain endosperm and the large embryo is completely surrounded by it. The endosperm layer is extremely thin, therefore the seeds may be described as markedly poor in endosperm. As compared with the seeds of hawthorn *(Crataegus)* the endosperm mass is here much smaller (P e l c and P t a k 1981).

Starch is always present in the endosperm of the species in point, in hawthorn seeds it is lacking. It may therefore be supposed that, in spite of the small amount of endosperm, this substance plays an important role in metabolic processes during germination. The afirmation of K u l p a (1974) that "in seeds described as endospermless in precise anatomical investigations as a rule may be found remains of endosperm and perisperm adhering to the seed coat, this, however, being of no major significance" (p. 23) does not seem quite correct.

The present investigations confirmed the earlier reported (P e l c and P t a k 1981) presence of endosperm in apple *(Malus),* pear *(Pyrus)* and *Chaenomeles* seeds. This fact has been omitted in the characteristic of *Maloideae* (F l o r a P o l s k a 7, 1955).

The species presently examined belong to the tribe *Maleae* (E n g l e r 1964) where the seed coat plays a protective role towards the diaspore; in such a case it is thick and hard. Within the genus *Crataegus* belonging to another tribe — *Crataegeae,* the seeds are enclosed in stones the wall of which arises from the inner layers of the fruit. The protective role here is fulfilled by the stone wall and the seed coat is very thin (P e l c and P t a k 1981). The diaspores of *Cotoneaster,* which also belongs to the tribe *Crataegeae,* are developed similarly as in the hawthorn.

The outer structure of the seeds shows good diagnostic features: in the first place it is the relief of the seed coat, next the localization of the site of attachment of the free part of the funiculus and further its appearance and the shape of the seeds.

The structure of the embryos gives no grounds for distinction of the species, there are only slight differences in the appearance of the radicles and their arrangement.

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Streszczenie

Zbadano morfologię i budowę wewnętrzną nasion jabłoni dzikiej (*Malus silvestris* Mill.), gruszy pospolitej (*Pyrus communis* L.) i pigwowca japońskiego (*Cheanomeles japonica* (Thunb.) Lindl.). Kształt nasion jest różny i mają one wybitne cechy diagnostyczne wyrażające się w pierwszym rzędzie w skulpturze powierzchni łupiny nasiennej a w dalszej kolejności w ułożeniu i wyglądzie miejsca przyczepu wolnej części sznureczka. W dojrzałych nasionach pod grubą i twardą łupiną nasienną występuje zawsze cienka warstwa bielma. Zarodek o dużych liścieniach i zazwyczaj prostym korzonku jest całkowicie otoczony bielmem. Wyniki pomiarów nasion zestawiono w Tabeli 1. Wyniki pomiarów zarodka, bielma i łupiny nasiennej w Tabeli 2. Rozmieszczenie materiałów zapasowych w bielmie i zarodku zestawiono w Tabeli 3. Załączone ryciny obrazują morfologię nasion i ich budowę wewnętrzną.