JERZY PYRGAŁA

THE RECONSTRUCTION OF AGRICULTURAL AND BREEDING ECONOMY IN PŁOCK MAZOVIA AT THE DECLINE OF ANTIQUITY

The problem of acquiring food by primitive populations is one of the most essential objects of research in historical sciences*. Its meaning is equally important in the late La Tène centuries and the period of Roman influence, on account of many characteristics telling the qualitative changes it had been undergoing then, in respect to early agriculture over the Polish lands.¹ A number of monographs or only articles, being part of more extensive works concerning settlement conditions, have been devoted to that question. Investigation comprised problems connected with agricultural and breeding economy over a vast territory, determined by the occurrence of finds showing systems of soil cultivation, the growing of corn-yielding plants, ploughing and harvesting techniques, processing of consumable grains and domestic livestock breeding.²

The map of archaeological sources leading to the knowledge of agricultural and breeding economy in Poland in the above mentioned periods, allows to conclude that chief data to our problem have been provided by finds spreading over Poland’s south-western provinces, i.e. Lower Silesia, south Poland, the central region of Little-Poland and foremost the countryside round Cracow. Upper Silesia and Great-Poland have provided a far less number of data, and the areas to the east and north of the river Vistula are till now only scarcely investigated in this respect.

The very disposition of localities that have furnished information about breeding and agriculture in the period under discussion, indicates that our knowledge of the subject is far from perfect. Even the areas offering a most considerable number of sources to our problems are not qualitatively uniform. Their majority, particularly those from Lower Silesia, have been acquired from various finds or only fragmentary research on settlements. Investigations carried out in Little-Poland managed to gather a richer record, seeking information in determined settlements, discovered in Nowa Huta-Mogila, Pleszów, Wyciąże and Zofipole. Other regions of Poland present finds reporting primitive techniques of soil cultivation such as colters and hoes from Toporów, Wieluń distr.³ and techniques of proc-
cessing corn, such as workshops manufacturing rotating grinding stones from Strzelce, Mogilno distr.\(^4\)

The geography of finds recording remains of corn in sites of the late La Tène and Roman influence period, is still less advantageous, for only few of them are identified. Again the areas of south Poland, Silesia and Great-Poland play a dominant role, whereas vast central areas of our country and those of the Vistula's middle and lower course are till now void of finds containing remains of corn.\(^5\)

We also know very little about domestic animals breeding (taking into account only those sites where the structure of herds purposely reared has been statistically grounded). We can now dispose of materials out of settlements. So, Little-Poland is represented by four sites, Silesia and Great-Poland by two each and only one speaks for west Pomerania. So, once more the middle and northern Vistula basin lack representation.

I. AGRICULTURE

Archaeological research carried out on two most important sites, contained in the mentioned microregion. i.e. the settlements of Poświętne and Kołożąb, Płońsk distr. assisted by a large number of specialistic studies in other scientific branches, have provided quite new sources to the knowledge of agricultural and breeding economy in the area of Mazovia. They are the first sources of that kind for the investigated microregion, and also the first in research on settlements that had been located in a zone of forest-and-wilderness.\(^6\)

Our studies have brought a number of direct and indirect data concerning agricultural economy. Their complexity included diverse methods leading to the chief aim.

(1) Palaeobotanic sources were provided owing to the investigation of daub that had persisted in the remains of dwelling and husbandry buildings and production kilns in the settlements of Poświętne and Kołożąb. As many as 787 selected fragments of daub that were the largest and best kept have been examined.\(^7\) These provided data about the cultivated corn species. It has thus been stated that the population of the two mentioned settlements had grown: ordinary barley (*Hordeum vulgare* L), millet (*Panicum miliaceum*) and wheat (*Triticum sp.*). The impressions of grains could be dated from the 1st to the 3rd cent. A. D.

(2) Palynologic sources — acquired in studies on layers of peat in Strachów and Kołożąb provided further data about corn cultivation. Cereal spectra evidenced a considerable amount of rye (*Secale cereale* L),\(^8\) that had not been discovered by palaeobotanic investigation of daub. Palyno-
logic data provided also valuable information concerning the extent of cultivated corn and changes occurring in the vegetation of the investigated territory possibly connected with rural economy.

(3) *Palaeopedologic sources* — acquired by the examination of virgin soil in the settlements of Poświętne and Kołożáb provided data concerning the quality of local soils and changes that had affected them during the past two thousand years, owing to environment alterations and agro-technical activity.

(4) *Archaeological sources to rural economy.*

(a) *The drying shed* discovered in the northern end of the Poświętne settlement consisted of two elements: a deep pit and an overgound construction. The flat-bottomed pit with vertical walls, 0.60–0.70 m deep had a diameter of 1.20–1.50 m across the top, its main feature was a clay firebed at the bottom. The pit was topped by a clay-and-wooden rectangular flat floor, partly covering its opening. Over the pit stood a wooden shanty construction, supported by four pillars standing along the pit’s edge on its long axis and by a number of wooden deals driven into the earth around its compass. This construction had been initially covered by a roof resting on eight pillars and extended over a space of 42 sq. m. The object was made to dry corn gathered from the fields. Moszyński states, on the basis of similar ethnographic relics evidencing primitive Great Russia’s agriculture, that such devices were typical for agriculture working in forest-and-wilderness low lying zones, with cool and damp climate and only few sunny days in the whole summer season. This is how the process of drying corn should have ran: a fire was lit at the bottom of the pit, the rectangular plaited floor laid across the top (it had therefore to be coated with clay) held back the flames, but allowed waves of heat and smoke to penetrate through slits to the overlying space. Sheaves of harvested fresh corn laid on the floor could dry owing to the gently emerging heat. On the basis of pottery found by the fireside, we could date the construction to the 1st–2nd cent. A. D. Traces of sharply pointed stakes were visible right round. Following Moszyński’s hypothesis, we should accept that these had formerly acted as a simple device of natural drying the mowed corn, for they are known to have been used in western Byelorussia and their functional connection with the carefully built drying shed is easy to guess. Kilns meant for burning lime may have also been adapted to drying corn. An example is the lime-kiln of Pruszcz Gdański, where, amidst clay rubble left by an overgound construction many corn grains had persisted.

(b) *Rotating grinding mills (or querns).* In the settlements we investigated eight specimens of that kind of relics have been discovered, five in Poświętne and three in Kołożáb. They were all found in closed objects, which allowed to establish their chronology. In Poświętne the nether
millstone was found inside a pit laid with boulder stones and on the basis of accompanying fragments of pottery it could be dated to a late La Tène or early Roman influence period. In one of the dwelling buildings, or rather in its household part, we found a fragment of quern, also a nether millstone, that may have reached back to the 1st–2nd cent. Another building yielded fragments of three rotating querns, upper and nether millstones. The building’s dimensions, its planning and inventory suggest that it was a space adapted to the manufacture of querns. Besides whole millstones there were many split and broken pieces of stone and only scanty fragments of pottery or other relics. The querns found here belong presumably to an early period of Roman influence.

In the settlement of Kołoząb a whole upper millstone was discovered to be an element of construction within a lime kiln, both could be dated to the 2nd cent. Two further nether millstones were found inside human dwellings, in their part used for husbandry duties, we placed them in the 1st–2nd cent. We conclude therefore that complex investigations carried out on these two settlements have supplied precious finds of rotating querns from the late La Tène or early Roman influence period. Corresponding objects have been found in north Great-Poland, Strzelce and Głogówek, Mogilno distr. but those of Poświętne and Kołoząb outnumber the finds of sites considered to be farming ones and lying in a steppe-and-forest zone of south Poland.

(c) Storage vessels, the function of which was good keeping of corn and corn products. Their discovery should be understood to have supplied indirect sources confirming the existence of agricultural economy. Large assortments of storage vessels have been found in both mentioned localities in husbandry pits, dwelling houses and semiterrenean huts forming the settlements.

This short review of sources shows that our complex research on settlements of the microregion managed to supply a fair, though still not perfect compilation of archaeological and natural sciences sources concerning agriculture.

We may, therefore, on their basis risk an attempt at the reconstruction of agricultural economy, being, however, well aware that many of our communications will often not outreach the limit of hypotheses, since the acquired document material still lacks important data that would clear the problems of research, the most essential of which would be the knowledge of tools for soil cultivation and implements necessary to the gathering of crops.

The weight of the raised problem, providing information about the development of economic conditions over Polish lands in the 1st millenary A. D. and its importance to the evolution of the investigated microregion,
authorises the undertaking of our task. Archaeological and natural sciences research on the discovered settlements will enable the analysis of our problem on a vast comparative level (restricted to a microregion scale), that may contribute to a confrontation of sources in a wider range than was till now conceived.

The pollen diagrams for Strachowo and Kołoząb indicate that settlement occurring here from the La Tène period had developed within a primitive landscape. The settlement region of Poświętne and Szpondowo and smaller objects, such as Michów, Strachowo and Drożdżyn, were surrounded by large and dense mixed leafy forests (Quercetum mixtum) and similar oak-and-horn beam woods (Quercetum Carpinetum) that were leading elements, further marshy clusters of elm (Ficario ulmetum campestris) and marshes covered with alder-and-ash trees (Alneto-Fraxinetum). In the Kołoząb settlement region largest stretches were covered by mixed pine-and-leafy forest (Pineto-Quercetum) and mixed beech-oak-and-horn-beam undergrowth also occurred here. The vast valley of Wkra grew alder-and-ash trees in marshes and in higher parts along terraces perhaps also elm trees.

Up to the time of settlement occurring in this countryside the share of tree pollen (AP) in the whole diagram for Strachowo (comprising therefore the region of the river Plonka), and chiefly for Poświętne and Szpondowo amounted to 75%, and in the total diagram for Kołoząb — about 60–65%. The rest were pollens of herbs (NAP), grass (Gramineae), carex (Cyperaceae) and other plants.

In connection with the appearance of settlement our diagrams evidence first traces of man’s agricultural activity proved by pollens of plants accompanying men, therefore of seetal vegetation with distinct representation of rye pollen (Secale cereale L.), corn weeds — cornflower (Centaurea), of synanthropic vegetation — ribgrass (Plantago lanceolata), sorrel (Rumex) and some ruderal plants — goosefoot (Chaenopodiaceae) and nettles (Urtica). The first, more exactly dated archaeological relics reach back to the 1st cent. BC and the beginning of the 1st cent. A. D. They are: impressions of corn grains and rotating grinding mills from the settlement of Poświętne.

Let us now separately consider sources concerning agriculture in the investigated settlements, grounding our examination on certain structural differentiations we have observed.

In the region of Poświętne, Szpondowo and other minor settlements the cultivation of corn steadily increased. The total diagram for Strachowo presents a rising curve, telling the steady growth of the quantity of corn pollens in spectra. It shows 1–2% at the turn of VII and IX pollen zone according to Firbas, and from 8 to 9% in the middle of zone X (historical
period), when the production of corn rises suddenly by a quantitative leap. In proportion with the increase of corn species is the curve of growth for corn weeds (cornflower) and synanthropic vegetation. In the archaeological material of the period we are discussing (VIII, IX and X pollen zone), palynologic data are confirmed in the continued appearance of corn grains and chaff impressions, the discovery of devices for drying fresh corn and further finds of rotating grinding mills. The most striking archaeological proof of a steady growth in corn production was the discovery of the presumed workshop, manufacturing rotating querns, in which three such specimens were found.

We shall now proceed to analyse the forms of spatial development of agriculture in the investigated region. Initial observations of curves presenting pollens of trees and plants prove the occurrence of a fact important for further consideration of agriculture viewed as a form of spatial economy. Namely, the steady and systematic increase of farming production does not injure the woodland vegetation. Oscillations in the quantity of arboreal pollens do not exceed 10%, neither do pollens of certain trees disappear to the advantage of other kinds, which is certainly an important matter. Both these events seem to evidence the fact that human activity tending to extend the cultivation of food-providing plants to wider areas at the cost of forests, did not considerably or extensively shake biocenic relations in the vegetation dress, to a degree visible in the discussed diagram. Distinct traces of clearing forests and diminishing grass-covered areas to the advantage of cultivated fields are obvious only in the middle of the zone X, where the share of arboreal pollen drops in the diagram to 50% and is connected with the disappearance of pollen shed by components of mixed leafy forests (AM) — oak, elm, linden, hornbeam (Carpinus), ash-tree (Fraxinus), alder (Alnus), to the advantage of pine-trees (Pinus) and birch (Betula). The share of grass pollen, carex and other herbs amounts to 33%, whereas the share of corn pollen grows to 17%.

Now appears the question of finding reasons explaining the above-mentioned state of affairs. How can we connect these two phenomena, apparently contradicting each other i.e.: no traces of forest extermination with the simultaneous extent of the areas adapted to the cultivation of corn, and the qualitative improvement of agricultural techniques, expressed in this case by traces of processing corn as a result of the growing production of food articles. There seem to be two aspects able to answer that question: 1) — natural conditions prompting the development of agricultural economy in the investigated region, 2) — the maturing evolution of settlement itself.

Aspect 1. Primitive settlers deciding to place their abode in a given area, found here natural conditions determined by elements of the
geographical environment, among which the really important ones are the kind of soil and the vegetation dress, constituting the most useful values in human life. It has already been proved that primitive settlers perfectly understood qualitative connections linking the properties of woodland complexes with the quality of soil. \(^{18}\) We can therefore surmise that when establishing their dwelling in this region, they had chosen most fertile lands, indicated by the growth of corresponding kinds of trees. \(^{18}\) In this case it was rich, black humus and fertile brown woodland soils, derived from clays and loams. Palaeopedologic investigation stated that the first i.e. black humus, presented higher values for cultivation, than what the same fields are able to yield today; the second, not having yet been subjected to a bleaching process, were richer in vital components than today’s pseudo-bleached soils. Black humus parts were the habitat of meadow-elm; over the brown clay-and-loam soils grew complexes of mixed leafy woods. \(^{14}\) Both these woodland complexes have particular regenerative qualities, to which attention has been drawn by Clark. \(^{15}\) This would explain that the agricultural expansion in this area did not require the destroying of great stretches of forest, \(^{16}\) and the earth adapted to farming could be cultivated for several and up to 20 years. \(^{17}\) Palaeopedologic examination has proved that black soils in the Poświętne region bear traces of longlasting and intensive cultivation, evidenced by a large content of \(P_2O_5\) in their layers. \(^{18}\)

Hence the following hypothesis seems to come forward: a system of double-field farming economy must have been applied here. \(^{19}\) While one field was ploughed and sown with corn, the other lay fallow under a fast regenerating leafy forest. Such a system of agriculture, conform to local natural conditions, did not seriously disturb floral relations, which is distinctly legible in the pollen diagram. Attention should be drawn to the scanty share of birch in pollen spectra. Birch trees, inclined to grow independently, quickly covered patches of land that had been burned out to gain free space. \(^{20}\) The lack of birch pollen in spectra would prove that the technique of burning woods had no considerable meaning in the process of acquiring land for cultivation in the investigated territory.

Among corn species we see a decided domination of ordinary barley and probably rye, prevailing over ordinary millet and wheat, which is only poorly represented.

A s p e c t 2. When starting to consider aspect 2, we observe the largest and most dense settlement concentration with closest dwellings and homesteads along the middle and lower course of the river Plonka. To the west of the river Żurawianka’s mouth the distance between settlements is from 2.5 to 3 km, and to its east they lie still closer to each other, spaces dwindling down to 1.5 or even 1.25 km, for instance between the
Map of natural landscape indicating cultivated land in the region of settlement assemblages lying at the mouth of the river Płonka falling into the Wkra: an attempt at the reconstruction of surface relations in the first centuries A. D.

settlements Poświętne-Michowo, Michowo-Szpandowo, Szpondowo-Strachowo, Strachowo-Drożdżyn. Such a concentration of human activity was bound to influence agriculture, which is the basic factor of economy. For the reason of establishing settlements so close to one another, must have been the great fertility of soils, determining settlers’ living conditions. Is seems, therefore, most probable that the very advantageous circumstances for farming, largely contributed to the development of a better system of rural economy, that resulted in a double-field system of cultivation.\(^{21}\)

Rural economy in the area of the settlement assemblage of Kołoząb should be considered from this point of view. Pollen diagrams indicate a steady increase of corn cultivation, evidencing here even more dynamic development than in the region of Poświętne and Szpondowo, shown by the share of corn pollen in spectra. In the pollen zone VIII it is 1–2\(^{0}/_{\circ}\), but at the turn of zone VIII and IX amounts to 8–9\(^{0}/_{\circ}\), reaching in the middle of zone IX its highest point for this phase of the sub-Atlantic climate — i.e. 12\(^{0}/_{\circ}\). At the turn of zone IX and X we observe a transitory break in the curve of increasing cereals production, told by the figure 2–3\(^{0}/_{\circ}\), but this is followed in the Xth zone by a repeated growth, reaching a level of 22\(^{0}/_{\circ}\) (for the region of Poświętne-Szpandowo the values of cereal curves would respectively be told by figures: 1–2\(^{0}/_{\circ}\), 4–5\(^{0}/_{\circ}\), 8–9\(^{0}/_{\circ}\) and 17\(^{0}/_{\circ}\)). Archaeological material confirms this dynamic trend of corn cultivation, for excavation works record impressions of corn grains found in the remains of buildings and rotating querns in assemblies dated to 1st, 2nd and 3rd cent.

We may further observe the cultivated area of the Kołoząb settlement assembly as compared with spatial forms of other floral concentrations. A quite different system from the analogous case in diagrams related to Strachowo are seen here. The steadily and quickly increasing surface of cultivated areas was reflected in qualitative and quantitative changes of the local vegetation dress. The pollen diagram for Kołoząb evidences more distinct differences of settlement expansion over woodland territories than that of Strachowo. Its first and most important proof are large-scale traces of clearing forests, particularly visible in the curve of birch pollen, the amount of which reaches 27\(^{0}/_{\circ}\) in the period preceding settlement; at the decline of pollen zone VIII, it drops violently to 2–3\(^{0}/_{\circ}\) only, at the turn of zone VIII to IX. It rises again in zone IX, representing some 5\(^{0}/_{\circ}\) of the total amount of pollen. At about the same time pine pollen begins to decrease, but the curve of cereals reaches its peak. In the second half of zone IX birch pollen quickly increases again, whereas pine pollen grows more slowly, with cereal pollen gradually regressing. The area of cultivation of cereals diminishes in comparison to what they had covered in the middle of zone IX. On the contrary the quantity of grass pollens grows up
to a level of 47–48\%\!. Birch pollen reaches again a point of over 20\% in
spectra of the turn of zone IX and X, but the area of mixed leafy forests
is seen to decrease (QM), for the share of its chief components: oak, elm
and lime tree is distinctly smaller in pollen spectra. Their gradual disap-
ppearance, clearly discernable at the decline of zone IX and the turn of
IX and X, is undoubtfully proof of a starting violent extermination of
leafy woodland in this settlement region. In the highest parts of zone X
the pollen of leafy specimens is only scarcely represented in the diagram
of Kołozab. The curve of birch and pine also drops rather distinctly and
the curve of cereals, herbs and grass grows decidedly.

Let us now attempt an explanation of such a floral situation in the
region of the Kołozab settlement assemblage. Its initial woodland were
mixed leafy and pine trees, growing in sandy soils formed out of boulder
clays. Only a further component of the vegetation dress was the concen-
tration of oak, elm and hornbeam on more fertile grounds. Palaeopedologic
research provided also proofs of the initial occurrence here of light, black
marshy soil, but not so rich as in the regions of Poświętne and Szpondowo
and covering a smaller surface. The population of Kołozab, which lay on
the periphery of the densely inhabited settlement sequence, stretching
along the banks of the Płonka river, shows also thinner population. To the
north of Kołozab, towards the lower course of the river Raciąznica and
southwards round the Naruszewka’s mouth, settlements become very loose.
An interesting feature is that these areas lie in the zone of pine-and-leafy
forest on sandy soils, but archaeological material evidences the intense
development of agriculture, confirmed by palynologic data, indicating the
swift growth of areas bearing cultivated corn. The spatial expansion of
agricultural economy, in spite of spreading on less fertile soil, could de-
velop only owing to a wide territorial extermination of pine-and-leafy
woodland. The dropping curve of birch and pine tree pollen, and the
simultaneous considerable growth of the corn pollen curve, speak of an
acute destruction of forests embracing vast territories around the Kołozab
settlement. It can also be assumed that the mentioned destruction was
accomplished by a burning technique, proved by the repeated pioneer
invasion of birch on the devastated and fallow lying stretches of land.\footnote{6 Archaeologia Polona XVI}

One more symptom, obvious in the diagrams of pollens, (occurring
simultaneously with the phase of destruction of pine-and-leafy forests)
is the decrease of pollen of trees being components of mixed leafy wood-
land that had second place in forest complexes of that time in the Kołozab
settlement assemblage, and had covered most fertile soils. It seems there-
fore clear that also those forests were sacrificed to acquire adequate vast
space for field cultivation. Archaeological, palynological and palaeobotanic
multi-directional investigations confirm the development in this region of intense agricultural economy, that made use of local natural conditions. When considering the areas of particular corn species, pollen diagrams attest most abundant crops of rye, the quantities of millet and barley may have been about equal, and wheat covered probably the smallest share of fields. The intense development of agricultural economy in permanent settlements favoured a higher model of cultivation, namely the double-field system.\textsuperscript{23} However, settlement in its early phases may have also been limited to the simpler one-field method, sowing grain on the vast patches of burned out forests.\textsuperscript{24}

Complex research on settlement relations over the mentioned area acquired materials allowing to draw certain more general conclusions concerning agricultural economy of the microregion fitted between the Vistula and the lower Wkra. In the light of the above observations it can moreover be assumed that symptoms of a new turn in the system of farming, discerned owing to excavations carried out in south Poland and concerning the late phase of the La Tène period and an early phase of Roman influence, may also be characteristic of some territories of central Poland and Mazovia.

Physiographic conceptions suggest that agricultural changes occurred not only in steppe-park-and-forest zones of south Poland favoured by fertile loess soils, but that a progress in agricultural economy is obvious also in Poland’s northern woodland zone, and what is more characteristic in its forest-and-wilderness subfacies, for the areas lying along the lower Wkra should be recognized as such.\textsuperscript{25}

Let us now consider the factors that influenced visibly the progress of agricultural economy in the investigated microregion. The problem of settlement stabilization in using a cultivated area, will come foremost here. It is particularly important because it allows to view the agricultural economy of the studied territory from the angle of its spatial development and its longlasting in a determined area. The investigated settlement assemblages, or their functional members, display distinct and rather uniform chronological continuity. The most intensely studied assemblage occurring in the Płonka basin indicates simultaneous existence of the settlements: Szpondowo, Poświętne and Kołożąb. Certain chronological divergences concerning establishing or abandoning the settlements are not essential to the discussed problem. The main outward symptom of stabilization and longlasting settlement in this region and in the period under consideration, was the spatial planning of settlements and assemblages and the forms of building for dwelling, farming and production.

The second important factor influencing forms of utilizing a given territory was the density of settlement in the studied area. The small distances
separating single settlements to the east of the Żurawianka’s mouth have been mentioned on page 77. The water network, the topographic localization and vertical formation of the territory, were often elements that had played a certain role in designing the right place for settlement and determining its borders. Thus settlements that had existed for several centuries in the same countryside, making use of initially fertile soils, enjoying advantageous living conditions and building their houses close to one another, determined also to a certain degree the spatial situation of the assemblage. The important factor of soil fertility can by no means be neglected in this problem.

It seems therefore probable that these three factors: settlement stabilization and its longlasting, dense habitation and initial soil fertility — provided appropriate conditions to agriculture that gradually adapted a system of permanent field cultivation. On the basis of observations so far acquired, and particularly the sources provided by the Poświętne settlement, we can assume that it was a system of double-field (woodland) economy. This is of course not a statement equivalent in meaning, that can be extended to wider areas of the forest-and-wilderness sub-facies. Materials from the settlement of Kołoząb indicating the violent clearing of large woodland territories, oblige the practice of precaution in drawing final conclusions, for specific local conditions may have had important weight in attaining a higher level of agriculture. This would concern areas characterized by weaker intensification of agriculture and worse sandy soils.

In such cases the one-field farming model may have persisted for long periods, but it seems admissible that a system of throw-over cultivation is no more applied in the investigated territory. It had been most probably substituted by a higher method of agricultural economy, connected with permanent farming alternating cultivation with fields lying fallow.

We shall now consider the second factor influencing the steady development of agricultural economy, expressed by the intensified cultivation which is visible in archaeological material and natural sciences sources and in the qualitative and quantitative increase of corn production. This factor is moreover directly connected with the above mentioned system of alternating cultivation and fields lying fallow. The growing demand for food influenced irrefutably the introduction of a more perfect system of soil cultivation leading to an increased production of corn. This gave rise to a general expansion of productive power, that can be observed in the investigated territory. Metallurgical production making large use of local raw material and remarkable for its technological quality of iron manufacture, developed quite particularly. Lime kilns provided abundant material to a highly developed tannery (tanning mostly beaver pelts); lime
was necessary in livestock breeding and building, perhaps also in foundry and textile industry.

Archaeological sources confirm the occurrence of perfected devices for grinding corn, i.e. rotating querns, which are a visible consequence of development and progress in farming technique, well grounded in the context of a general trend of production power in this region.

Rotating querns used for grinding corn and the discovery of a workshop probably adapted to their production, is the most outspoken archaeological proof attesting a striking progress of technical development in agriculture and the considerable increase of corn production. Further archaeological proofs follow, among which the discovery of a drying shed — a typical device for agriculture operating in a damp climate — comes foremost. Also palynologic and natural sciences investigations give a clear picture of the intensification of farming connected with technically improved implements. It is true that excavation research has not discovered tools directly useful to the ploughing of fields and gathering corn in the studied region, but it has provided indirect proofs, such as the shed, built and cleverly adapted to the purpose of drying fresh sheaves of corn. The latter also evidences the fact that ripe corn had been harvested by means of implements such as wide-arched sickles of an improved type, able to cut efficiently the stems of standing corn. The lack of finding tools for ploughing the soil and gathering crops, should not exclude their use in the given time for the growing level of farming economy and the cultivation of black clay and loamy soils, certainly required appropriate utensils. On the other hand, the high standard of local metallurgy allows to suppose that farmers should have been well provided with good iron tools necessary for their work.

We are short till now of adequate archaeological proofs concerning the technique of agriculture. They are beyond the reach of archaeological research methods and therefore remain in the sphere of conjecture and speculations, supported by indirect substantial sources. Having to our disposition the achievements of natural sciences, chiefly palynological and palaeobotanic data, we shall attempt at forwarding certain suggestions concerning agricultural technique, keeping to quite hypothetic forms.

Palynologic research carried out in Poświętne and Szpondowo evidences pollen diagrams lacking traces of clearing forests, which is told by the curve of birch pollen, similar to that of other woodland components of this region. Quite different are the pollen diagrams for the settlement of Kołoząb, where first of all the curve of birch pollen and further that of other trees composing mixed leafy forest, distinctly indicate the most intense clearing of woodland. Birch, being a pioneer species, boldly enters areas lying fallow after the burning out of a mixed pine-and-leafy forest.
This would confirm the fact that, besides clearing forests by a burning technique, the same system may have been applied to agricultural economy. The large quantity of millet grain impressions found in Kołożąb suggests its cultivation on land that had been recently cleared by burning woodland, for millet was known to provide rich crops when sown directly on patches made bare by fire. Although the cultivation of millet was not necessarily linked with the burning of woodland, the above mentioned fact stated in Kołożąb is worth noting, particularly as compared with impressions of corn grain in Poświętne, where the amount of millet grain impressions is third in relation to those of rye and barley. We remember that the settlers of Poświętne avoided the technique of wide burning forests, while in Kołożąb the situation was different. Here are figures evidencing the proportions of corn species in our finds for both mentioned localities (neglecting the presentation of rye, otherwise determined by palynologic research):

<table>
<thead>
<tr>
<th></th>
<th>Barley</th>
<th>Wheat</th>
<th>Millet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poświętne</td>
<td>219</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Kołożąb</td>
<td>57</td>
<td>1</td>
<td>57</td>
</tr>
</tbody>
</table>

Wide differences in the species area of corn cultivation are here eloquent.

A dominant place among the cultivated fields for the region of Poświętne fell to ordinary barley and most probably rye with only a small per cent share of millet and minimum part of wheat. On the contrary, in Kołożąb where rye is supposed to have prevailed, the amounts of barley and millet are equivalent. Thus, accepting highest quantities for rye and lowest for wheat, the figures for barley and millet indicate basic differences in the economy of these settlements. Barley prevailed in Poświętne in proportion to Kołożąb by a relation 3.84 : 1, whereas millet shows in Kołożąb a prevalence of 8.14 : 1 against Poświętne. The last mentioned proportion suggests that the technique of burning forests played a more eminent role in Kołożąb than in Poświętne.

A characteristic feature in corn cultivation for the investigated region is the mass occurrence of rye and ordinary barley. Both these species were known already in the Neolithic Age, but their large amount in field cultivation appeared only in the late La Tène and Roman influence period. This event should be explained by the high level of agricultural economy spreading at that time, as shown by growing quantities of high-quality winter kinds of corn.

Rye is known to have long roots and therefore requires deeply ploughed soil, but gives best results in permanent farming. It is supposed that rye had been sown in those times as a winter crop. Its essential qualities are: resistance to cold and infection, short vegetation period and easy adaptation to poor kinds of soil.
The cultivation of corn plants and their percentage in acreage seem to confirm the forwarded supposition of farming being here permanent with the system of alternating cultivated and fallow lying fields. In the matter of technique, the present state of research does not allow to step out of a generally conceived hypothesis. Certain, already mentioned, premises would show the use of burning technique applied in the zone of pine-and-leafy forests and of sandy soils characteristic in the settlement of Kołoząb. But on the heavier and more fertile soils of Poświętne and Szpondowo (partly also Kołoząb) models of a correct ploughing economy could then germ and prosper, and the technique of burning is seen to recede. Here arises the problem of fertilizing the soil, prompted by developed cattle breeding that could provide necessary quantities of dung.38

**Table 1. Cultivated plants and weeds from the settlements in Plock Mazovia (1st cent.C.B.–3rd cent. A.D.)*

<table>
<thead>
<tr>
<th>Site</th>
<th>Kind of cultivated plant</th>
<th>Weeds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ord. barley</td>
<td>ord. millet</td>
</tr>
<tr>
<td></td>
<td>(Hordeum vulgare L.)</td>
<td>(Panicum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>millaceum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L.)</td>
</tr>
<tr>
<td></td>
<td>wheat</td>
<td>ord. rye</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Triticum</td>
</tr>
<tr>
<td></td>
<td></td>
<td>spelta</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Secale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cereale L.</td>
</tr>
<tr>
<td></td>
<td>coarse</td>
<td>oats</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Centau-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rea)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Avena strigiosa Schreb)</td>
</tr>
</tbody>
</table>

| Poświętne  | 219 impres. of grain,    | 7 impres. of grain, |
|            | 3 im. of chaff, 3 im.    | 1 impres. of grain, |
|            | pres. of ear             | many traces in     |
|            |                          | pollen spectra     |

| Kołoząb    | 57 impres. of grain,     | 57 impres. of grain, |
|            | many impres. of chaff,   | 1 impres. of grain, |
|            | 1 imp. of leaf           | many traces in      |
|            |                          | pollen spectra      |

| Drozdowo   | —                         | —             |
|            |                          | many traces in |
|            |                          | pollen spectra  |

| Dzierząźnia| —                         | —             |
|            |                          | many traces in |
|            |                          | pollen spectra |

*After the palaeobotanic elaboration of M. Klichowska and M. Ziembińska-Tworzydło*
It is difficult to formulate more precisely just now our attitude in the matter of agricultural technique, we shall therefore only mention the possibility of applying the annealing technique in dependence on local conditions in the region of Kołoząb, and stating the purely ploughing technique (perhaps used along with the annealing one) in the region of Poświętne and Szpondowo. The latter requires, however, more thorough research.

The introduction of our article signifies the very difficult problem of reconstructing a picture of agricultural economy in the investigated period, as it requires gathering an appropriate quantity of archaeological and natural sciences sources and accomplishing their detailed analysis. In many cases the knowledge of particular problems concerning agricultural economy outgrows the capacity of archaeological methods and needs closest collaboration with natural sciences. It seems, therefore, that complex research on the settlement of microregions, where a concentration of adequate means and research methods of diverse scientific disciplines over a small territory, may play an important role in acquiring the knowledge of processes occurring in the whole of agricultural economy.

II. DOMESTIC LIVESTOCK BREEDING

Livestock breeding is a branch of economy most closely connected with the local geographic environment. This connection is best obvious in the matter of climatic conditions and the vegetation.

Basic excavation sources throwing a light on domestic animal breeding is the osteologic material, obtained during research in the territory of two ancient settlements: Poświętne and Kołoząb. The material consists of bone fragments of various dimensions and also whole bones and parts of skeletons. 84

The settlement of Poświętne provided about 1,329 bone remains.

In the whole of bones discovered it has been possible to recognize and state the species of 877 bone remains, which makes 65.99% of the total material. Some 452 fragments were not fit to be recognized because they were badly crushed, these made about 34.01%. Out of the labelled material 820 pieces were those of domestic animals (93.5%). In this group cattle prevailed (385 fragments making 43.9% of the recognized material and 46.96% of the domestic animals). Next were remains of swine, 142 pieces (16.19% and 17.31% respectively). Horses represent 107 remains out of the total number (12.20% and 13.05%). Dogs have left 94 fragments (10.7% and 11.46%). Sheep and goat have been noted by 92 fragments (10.49% and 11.22%).
Out of the number of 358 bone remains found in Kołożąb as many as 174 were possible to identify, making 48.6% of all the material. Domestic animals (157 fragments) make 90.23%. No birds bones occurred here.

Among domestic animals cattle held the dominating position, as its 103 bone remains represented 59.2% of all the material, in which 65.6% belonged to domestic animals. The second place falls to the 24 pieces of horse bones (respectively 13.79% and 15.29%); the third quantity are the remains

<table>
<thead>
<tr>
<th>Table 2. Poświętné — Percentage composition of bone remains*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domestic animals</strong></td>
</tr>
<tr>
<td>horse</td>
</tr>
<tr>
<td>cattle</td>
</tr>
<tr>
<td>swine</td>
</tr>
<tr>
<td>sheep and goat</td>
</tr>
<tr>
<td>dog</td>
</tr>
<tr>
<td><strong>Wild animals</strong></td>
</tr>
<tr>
<td>stag</td>
</tr>
<tr>
<td>roe deer</td>
</tr>
<tr>
<td>wild boar</td>
</tr>
<tr>
<td>beaver</td>
</tr>
<tr>
<td><strong>Birds</strong></td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

*After the elaboration of S. Godynicki

<table>
<thead>
<tr>
<th>Table 3. Kołożąb — Percentage composition of bone remains*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Domestic animals</strong></td>
</tr>
<tr>
<td>horse</td>
</tr>
<tr>
<td>cattle</td>
</tr>
<tr>
<td>swine</td>
</tr>
<tr>
<td>sheep — goat</td>
</tr>
<tr>
<td><strong>Wild animals</strong></td>
</tr>
<tr>
<td>stag</td>
</tr>
<tr>
<td>beaver</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

*After the elaboration of S. Godynicki
of swine — 17 fragments making 9.77% and 10.83%; those of sheep and goat displaying 13 fragments (7.47% and 8.28%) may be ranged to the fourth place.

The remains of cattle are most abundantly found among all the fragments of domestic animals in the settlements of Poświętne and Kołoząb. We judge them to have mostly belonged to young animals as well as to well grown up cows and bulls. All the diverse pieces of animal skeleton are found among them, so they evidence typical kitchen refuse. It has been possible to calculate the number of animals that had left their bone remains in Poświętne fixing their number to 15. The dimensions of cattle bones from Poświętne and Kołoząb show their belonging to the race of shorthorns (*Bos taurus brachyceros*) and also to a small number of large bison-like animals (*Bos taurus primigenius*). The prevailing number of bones belonging to the first group proves that shorthorns were favoured in this part of the country, dominating largely over the second group. This difference has been stated also in other Polish lands, as told by excavations in Nowa Cerekwia, Głubczyce distr., Słup, Środa distr., Igolomia, Proszowice distr., Tropiszów, Miechów distr., and Cedynia, Chojna distr. The first group was a primitive race of rather small build. Similar specimens excavated in the early mediaeval stronghold of Cedynia show that the average height of withers in cows of brachyeric race fitted into the limits of 1–1.17 m. Such dimensions are much like those of Celtic shorthorn cattle, known earlier from the settlement of Manching, where the average height of withers of a bull amounted to 1.20 m and of cow to 1.10. Their dimensions depended of course also on their life conditions, the quantity and quality of feeding stuff, particularly during the winter period.

Shorthorn cattle presented the advantage of being resistant in difficult conditions of a cool and damp subatlantic climate, with standing well the fluctuations of temperature and humidity, stated in the basin of the rivers Płonka and Wkra. Its dimensions show standard figures. As all the remains of bones were mostly kitchen refuse, it may be assumed that cattle was bred in the aim of acquiring meat, therefore beef had probably been a basic element of the population’s food in the given period over the investigated territory. The consumption of beef calculated by bone remains, outweighed about three times the consumption of pork, and some four times that of mutton. The clever splitting of an animal skeleton into parts is proof of a certain skill in quartering the flesh for meat consumption. In the light of archaeological data it can be presumed that the developed level of cattle breeding provided also milk and its products. In the majority of dwellings vessels and implements necessary for storing and processing milk are found in great numbers. They are milkpots and sieves, large clay pails with opening in the bottom used to the production of cheese. The con-
frontation of historical sources concerning primitive cattle breeding of that
time in central Poland, Lithuania\cite{42} and Polesie,\cite{43} clearly shows that the
level of milk production of cows bred in the investigated territory was very
low, calculated according to the quantity of milk provided by one cow in
a day’s unit. It has been stated that in the 17th century in central Poland
the average quantity of milk produced by a single peasant cow was about
720 l of milk yearly, which equals the production of some 20 kg cheese;\cite{44}
we may expect that these figures would show in the best of cases the upper
limit of the efficiency of cows bred in the period we are considering. It
may be accepted that the low standard of milk production stated above
was mainly caused by the fact of cows suffering hunger in the winter
months.

In all hitherto completed studies on cattle breeding the question of
consumption of milk and dairy products was scarcely noticed and even ne-
gated.\cite{45} The results we have obtained seem to indicate the importance of
milk and its derivatives in the food of the local population.

Cattle breeding provided also a very useful raw material in the economy
of the region we have investigated, namely hides. A number of archaeolog-
ical sources evidence the high development of tannery in this part of the
land.

The small amount of bone remainders from the skeletons of other
mentioned cattle species shows that bison-like cattle played also a certain
role, though was not very important.\cite{46} Its specimens were very strong,
enduring in hardships, resistant to diseases and heavy climatic conditions
and not difficult in the choice of food. They were sturdily built and bred
chiefly to obtain meat. The quantity of milk produced by those cows was
on the contrary very small.

The osteologic material from the settlements of Poświętne and Kołoząb
are largely remains of horse’s bones, that had belonged to well grown spec-
imens. The particular parts of skeleton they have left indicate that they
came from those animal quarters that were best provided with flesh, which
would prove the consumption of horse meat in the mentioned settlements.
Similar phenomena have been observed also in Nowa Cerekwia, Głubczyce
distr. and in Cedynia, Chojna distr.\cite{47} Horses’ hides were probably
very useful. The horses bred in Poświętne and Kołoząb were of small or
mean dimensions, with a withers height 1.20–1.44 m. They did therefore
not differ much from horses the remains of which have been found in other
sites, namely Słup, Środa Śląska distr., Nowa Cerekwia, Głubczyce distr.,
Cedynia, Chojna distr. and Ossowa, Suwałki distr.\cite{48} The small horses kept
in Poświętne and Kołoząb were much like tarpans (Equus caballus Gmelini)
and like the Polish or Przewalski type of horse (Equus caballus Przewalski).
The somewhat bigger specimens may have been close to the Celtic
horses from Manching or to those coming close in dimensions to Arabian horses from Slup, or to the type of Speed, known from the settlement of Nowa Cerekwia.

Some of the horses, whose bone remains are found by excavation research, may have been drawn from other sources. For instance Krysiak speaks of bones coming from horses that used to be caught wild. He suggests, on the basis of bone material found in Bródno Stare, that the bigger horses came from well bred herds and had a sort of Arabian type, while the smaller ones, with a silhouette of the wild tarpan, may have been caught wild and domesticated. The question has, however not been studied enough yet to allow its full determination.

The remains of swine's bones are second after horse in the group of domestic animals. The pigs bred in the settlement of Poświętne and Kołożab (Sus domestica L.) were derived from the European wild boar (Sus scrofa ferus L.) and were rather small, reaching a height of 0.7 m which is similar to that of pigs we already know from other sites of that period. Their remains came from young and also well grown specimens, and were typical small pieces cut out and thrown away in the processing of food; this would indicate making good use of meat and bone marrow to the purposes of consumption.

Fragments of sheep and goat's bones (Ovis et Capra) present the smallest group in the total of domesticated animals, and are remains of young and of grown up specimens. The sheep were very small, some 0.60 m tall. The scarce quantity of larger fragments and the lack of skulls make an exact determination of their race impossible.

The remains of dog's bones in Poświętne (Canis familiaris L.) belonged most likely to at least six dogs. The animals were probably of a short-muzzled race, with type and dimensions like the German shepherd's dog.

A very important factor shaping the extent of domestic animals breeding was feeding stuff. This means appropriate spaces kept for pastures and still more important storing of fodder for the winter months. It is generally accepted that most of the territories used for the grazing of animals, particularly in the woodland zones, were forests and fields lying fallow around the settlements. We shall therefore consider what kinds of woodland spaces occurring here should have presented the greatest advantage for livestock breeding. The microregion we have studied was placed in the zone of leafy forests, that covered some 50–60% of the wooded surface. Their rich vegetation offered very good conditions for primitive animal breeding. Forest undergrowth, containing also plants growing for two years, provided excellent fooding stuff. The animals sought their food in brushwood covering the ground of elm-, lime-tree and oak-tree forests, as well as those of ash-tree and birch-tree. The branches, leaves and bark of those trees were the
chief component of food in that primitive breeding system. Thanks to those phitosociological conditions, mixed leafy forests offered most advantageous conditions for growing cattle, horses and swine, providing rich green pasture in the summer months. Large stretches of forest complexes with trees growing close together had dense brushwood, which created a specific woodland microclimate, characterized milder winter temperatures and a nearly total lack of heavy snow falls. The natural conditions of leafy forests allowed animals to graze there also in the early winter season. It should indeed be supposed that settlement regions lying along the valley of the river Płonka, therefore: Kluczewo, Szeromin, Piaski, Poświętne, Michowo, Strachowo and Droźdżyn had convenient territories for the grazing of cattle, horses and swine, on account of their placing in the zone of leafy forests.

The question of providing vegetation food for animals was rather different in the region round Kołożąb. This settlement was fitted into the zone of mixed pine-and-leafy forests, that were not so rich in feeding stuff for the animals, because of their vegetation composition. These complexes have few elm- and ash-trees, the sprouts and soft shoots of which were a natural component of feeding stuff. They were also not so useful for early winter grazing, being often covered with thicker layers of snow. It is clear, therefore, that leafy forests, although occurring on far smaller stretches of land, played a more important role in the breeding of domestic animals.

The use of forests growing over marshy lands was very diverse. Clusters of elm-trees grew mostly in boggy but very fertile patches and were considered to be useful if not too damp. The sprouts and shoots of elm-oak- and ash-tree gave rich brushwood, very good for summer grazing and the closely growing trees averted also heavy snow fall in winter. It has, however, been stated that that kind of woodland covered relatively small areas of the investigated territory and should have probably appeared only in the region of Poświętne and Szpondowo.

The greatest stretches of boggy forests were clusters of alder- and ash-tree covering the valley of Płonka and its tributaries, and the valley of Wkra. Their rich vegetation was advantageous for pasture, not very useful, however, over the whole year, being too often flooded by river water. Moreover, damp pastures produce acetyfied vegetation of low feeding value.

Boggy patches of woodland were mostly exploited in the settlement assemblage of Kołożąb, where the valley of Wkra shows large hypsometric differentiation, providing thus wide stretches of dry land.

Most useful are no doubt pastures in the forests growing in the marshy lands where the vegetation starts early in spring, allowing the animals
which were hungry all winter, to find rich and succulent food in the green spaces, lively with fresh grass. Boggy woods did not offer such advantages, for their excessive humidity influenced the climate.

A very serious problem weighing on the economy of those distant times was collecting a sufficient quantity of fodder for the winter period. The extent of livestock breeding depended indeed mostly on that factor.

Archaeological material discovered in the investigated region has not displayed any implements useful for the gathering of grass and making or storing hay. The only accessible information in that respect is our knowledge of the vegetation dress, richly covering meadows, marshes, and also the ground of woodland. Settlements certainly made use of it in spring, summer and autumn, but the critical period was winter.

Since our investigations have stated that the inhabitants of Poświętne and Kołożab kept large numbers of cows, horses and other domestic animals, we are obliged to admit that they managed to collect the indispensable quantity of feeding stuff to keep the animals from starving, all the more so that in some other sites of Mazovia (e.g. Kutno and Brześć Kołonia, Białobrzegi distr.) implements used for the harvesting of hay have certainly been found. It can moreover be supposed that the animals could feed on what the forests provided, i.e. branches, twigs, shoots and dry leaves thickly covering the forest ground, and that their owners were probably busy collecting brushwood and undergrowth to prevent the livestock’s starving. On the basis of data concerning the Scandinavian countries, Clark determined the volume of food necessary for the keeping of a cow weighing about 150 kg, stating its amount to 1,000 kg of leaves in bundles. He supposes that twigs and bark also constituted the winter fodder.

We may further surmise that the animals enjoyed some kind of accommodation for the fiercest winter months. There are scanty traces of surface sheds in the sites of Poświętne and Kołożab. The existence of large closed objects for keeping cattle have been stated in north Germany, e.g. Feddersen-Wierde.

Livestock breeding in the investigated region may have been closely connected with agriculture economy, which had then reached a higher level of soil cultivation, applying the alternating system of sowing fields with corn or having them lie fallow in a two-fold or three-fold sequence. Some settlements probably had well established agriculture, for palaeopedologic investigations indicate intense cultivation and drawing profit from the soil. These data suggest that well developed livestock (particularly cattle) breeding could provide considerable quantities of animal dung that improved the efficiency of the soil.

A second aspect stressing the close connections of agriculture with livestock breeding are data evidencing the use of draft animals to the culti-
vation of fields. There are traces in Poświętne and Kołoząb of bison-like cattle (*Bos taurus primigenius*) having been used here. Those specimens were tall, strong and resistant in difficult living conditions, but not well fitted to living in woodland zones. They could be useful only for hard work and were rather rarely kept. This problem requires further archaeological and palaeozoologic studies.

Ecological conditions in the investigated region were less advantageous to the breeding of sheep. Closely growing trees spread their shade over the grazing grounds, the very damp climate and boggy land brought diseases and proved harmful to the development of that species. This is reflected in the scanty amount of sheep's bones found by excavation research, they can therefore only be ranged to the fourth place in both the mentioned settlements. Even supposing that sheep were bred only for their fleece, their share in the local livestock was relatively small and did not play the important role of cattle, horses and swine.

While approaching the end of this chapter, describing the breeding economy of our settlement microregion, we shall now consider the problem in two chronological and spatial aspects:
1) domestic livestock breeding in Mazovia in a chronological section from the decline of the Bronze Age to the 12th cent.,
2) domestic livestock breeding in Polish lands from the first cent B.C. to the 4th cent. of the Christian era.

Table 4 presents general data concerning sources. It clearly shows that the prominent role among domestic animals was played in that period by cattle. (We lack till now well grounded statistic data for Hallstatt and the early La Tène period). The per cent share of cattle in livestock breeding amounted in the mentioned centuries to about 50%o. In the period of Roman influence it was highest in Kołoząb, reaching then 65.9%o and lowest in a settlement from the 11th–12th cent.—Sypniewo, Maków Mazowiecki distr. (38.16%o).

Horse breeding stood highest and was most equal in the period of Roman influence (15.29%o for Kołoząb and 13.05%o for Poświętne), and partly in the early mediaeval stronghold of the 10th–11th cent. in a quarter of Warsaw, Bródno Stare (23%o). The number of horses kept in Mazovia in the early Middle Ages seems to be dropping from the 11th cent. onwards.

The oldest centuries of the early Middle Ages show a turn in the breeding of swine. At the time of Roman influence it oscillated in the limits of 10–17%o of the general number of animals, keeping a second and third place, equal to the number of horses; it increases considerably beginning with the 6th cent. as seen in the stronghold and settlement of Szelići, Płock distr. It holds there a second place approaching in number the per cent share of cows.
<table>
<thead>
<tr>
<th>Site</th>
<th>Chronology</th>
<th>Domestic animals (%)</th>
<th>General % of animals bred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miszewko Strzałkowskie, Płock distr.</td>
<td>III-IV period of the Bronze Age</td>
<td>cattle 54  swine 12  sheep-goat 9  horse 0.8</td>
<td>75.8</td>
</tr>
<tr>
<td>Kołożąb, Płońsk distr.</td>
<td>1st cent. B.C. — 4th cent.</td>
<td>cattle 65.9  swine 10.8  sheep-goat 8.20  horse 15.10</td>
<td>100</td>
</tr>
<tr>
<td>Poświętne, Płońsk distr.</td>
<td>1st cent. B.C. — 3rd cent.</td>
<td>cattle 47  swine 17.31  sheep-goat 11.22  horse 13.05</td>
<td>88.58</td>
</tr>
<tr>
<td>Szeligi, Płock distr. stronghold Szeligi, Płock distr. settlement Bródno Stare, Warszawa</td>
<td>6th-7th cent.</td>
<td>cattle 42  swine 36  sheep-goat 19  horse 1</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bródno Stare, Warszawa stronghold Synniewo, Maków Mazowiecki distr. settlement Bródno Stare, Warszawa settlement Synniewo, settlement Maków Mazowiecki distr.</td>
<td>10th-11th cent.</td>
<td>cattle 52  swine 28  sheep-goat 8  horse 9</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11th-12th cent.</td>
<td>cattle 43.85  swine 39.01  sheep-goat 10.96  horse 4.93</td>
<td>98.75</td>
</tr>
<tr>
<td></td>
<td>10th-11th cent.</td>
<td>cattle 49  swine 20  sheep-goat 8  horse 23</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>11th-12th cent.</td>
<td>cattle 38.16  swine 33.96  sheep-goat 9.39  horse 4.28</td>
<td>85.79</td>
</tr>
</tbody>
</table>

Sheep breeding did not play an important role in the chronological section we are considering, only slightly outrunning the number of horses in the later early mediaeval phase, advancing thus from the fourth to the third place.

As to the per cent share of bone remains belonging to domestic animals in relation to the whole of the osteologic material, a characteristic thing is its larger per cent occurring in the material of the Roman influence period than in the early Middle Ages.
Table 5 evidences to a certain extent the state of domestic animals’ breeding in Polish lands in the late La Tène and Roman influence period. It shows the decided predominance of cattle, reaching always 50% of the total. The number of other animal species appears to be much differentiated.

Pigs were most numerous in Silesia, Great-Poland and west Pomerania, showing 26–30% of all the number of heads. It was lowest in Mazovia, keeping to the level of 10–17% among the other animals.

Table 5. Domestic livestock breeding in Polish lands in the late La Tène and Roman influence period

<table>
<thead>
<tr>
<th>Site</th>
<th>Chronology</th>
<th>Domestic animals in %</th>
<th>General % of domestic animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cedyńa, Chojna distr.</td>
<td>2nd-3rd cent.</td>
<td>50.9</td>
<td>100</td>
</tr>
<tr>
<td>Poznań</td>
<td>3rd cent.</td>
<td>62.9</td>
<td>97</td>
</tr>
<tr>
<td>Piwonice, Kalisz distr.</td>
<td>1st cent. B.C.</td>
<td>52.04</td>
<td>94.26</td>
</tr>
<tr>
<td>Poświętne, Płońsk distr.</td>
<td>1st cent. B.C.</td>
<td>1st cent. B.C.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5th cent.</td>
<td>52.04</td>
<td>94.26</td>
</tr>
<tr>
<td></td>
<td>3rd cent.</td>
<td>47</td>
<td>88.58</td>
</tr>
<tr>
<td>Kołozab, Płońsk distr.</td>
<td>1st cent. B.C.</td>
<td>65.90</td>
<td>90.23</td>
</tr>
<tr>
<td>Gosławice, Opole distr.</td>
<td>1st cent.</td>
<td>60.8</td>
<td>99.2</td>
</tr>
<tr>
<td>Opole—Zakrzów, site 11</td>
<td>4th cent.</td>
<td>73.8</td>
<td>99.2</td>
</tr>
<tr>
<td>Rogów, Krapkowice distr.</td>
<td>2nd-3rd cent.</td>
<td>70.5</td>
<td>100</td>
</tr>
<tr>
<td>Wojnowice, Głubczyce distr.</td>
<td>4th cent.</td>
<td>61.2</td>
<td>100</td>
</tr>
<tr>
<td>Nowa Cerekwia, Głubczyce distr.</td>
<td>1st cent. B.C.</td>
<td>34.7</td>
<td>94.1</td>
</tr>
<tr>
<td>Słup, Środa Śl. distr.</td>
<td>2nd-3rd cent.</td>
<td>59.3</td>
<td>100</td>
</tr>
<tr>
<td>Nowa Huta — Mogiła Igołomia, Proszowice distr.</td>
<td>3rd-4th cent.</td>
<td>40.3</td>
<td>98.6</td>
</tr>
<tr>
<td>Wola Duchacka, Kraków distr.</td>
<td>2nd-3rd cent.</td>
<td>65.0</td>
<td>100</td>
</tr>
<tr>
<td>Kobylniki, Busko—Zdrój distr.</td>
<td>1st-2nd cent.</td>
<td>—</td>
<td>73.3</td>
</tr>
<tr>
<td>Aleksandrow, Busko—Zdrój distr.</td>
<td>1st cent. B.C.</td>
<td>58.0</td>
<td>99</td>
</tr>
<tr>
<td></td>
<td>3rd-5th cent.</td>
<td>1st cent. B.C.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2nd cent.</td>
<td>75.76</td>
<td>93.94</td>
</tr>
</tbody>
</table>

— indicates a very low number of heads.
On the basis of palaeozoologic data from Poświętne and Kołożab we assume that Mazovia held the lead in horse breeding, reaching the highest per cent index among other Polish lands.

Sheep breeding was more uniform, giving, however, distinctly way (except the case in Nowa Cerekwia) to the breeding of cattle and swine.

III. THE EXPLOITATION OF NATURAL RESOURCES

The environment of settlements developing in the investigated area created convenient conditions to the exploitation of natural resources. There were practically no limits to their large and universal exploitation, owing to their profusion and primitive state. Vast stretches of leafy and mixed woodland offered perfect habitat to fallow deer, the most attractive wild animal for primitive men; beavers built their dwellings in soaked and boggy undergrowth; fishes were abundant in all the rivers and particularly the Wkra. The very rich surrounding vegetation produced fruit, herbs and edible creepers and roots. Therefore every possibility of enjoying hunting, fishing, gathering food in the forests and keeping bee hives stood here open before the settlers.

We shall, however, consider only those branches of productive exploitation of natural resources that are confirmed by archaeological sources.

HUNTING

Most abundant material evidencing hunting in the investigated area has been provided by palaeozoological research in the settlements of Poświętne and Kołożab. They are a basis for the drawing of conclusions concerning this field of settlement activity.

In all the osteologic material excavated in the settlement of Poświętne (see Tables 2 and 4) 56 remains (exactly 6.39%) are bones of wild animals acquired by hunting. The remains of stag (40 fragments) make 4.56% of the whole osteologic material, but 71.43% of the remains of game. Further: roe deer — 9 fragments (1.03% and 16.07% respectively), wild boar — 4 fragments (0.46% and 7.14%) and beaver — 3 fragments (0.34% and 5.36%). It should here be remarked that the remains of wild boar, being very much like those of the domestic pig may have been confused with the latter.

In the bones of the Kołożab settlement (see Tables 3 and 5) 17 remains were those of wild animals, making 9.77% of all the material. We recognized only: — stag by 9 fragments, therefore 5.17% of the total quantity of
bones found here and 52.9% of the remains of wild animals, and: — beaver by 8 fragments (4.60% and 47.06% respectively).

Among the remains of horses part of them may have belonged to animals caught wild, which would shift the established % relation of domestic animals to those living wild.67

Here are details and figures determining more exactly the results of hunting in the two investigated settlements. We see more differentiation in the settlement of Poświętne, with fallow deer: — stag (Cervus elaphus L.) and — roe deer (Capreolus capreolus L.) decidedly prevailing and making 87.50% of all the remains of game. The fragments of stag’s bones showed grown up specimens of mean and large dimensions. The remains of roe deer were chiefly horns chopped off the skull or those shed by the animals in spring and found in the woods.

Fragments of wild boar’s skeleton (Sus scrofa L.) were not numerous and badly crushed. It can be supposed that these animals were far more difficult to hunt than fallow deer. Also the very few remains of beaver’s bones indicate the limited chance of catching individuals of that species in the region of Poświętne.

The problem of hunting has a different aspect in the settlement of Kołożab. The remains of only two species — stag and beaver are represented here, with a very high per cent of beaver.

The above data indicate that the animal most often hunted in this region was stag — the typical representant in the fauna of leafy and mixed forests, generally occurring in Polish lands, in the period we are concerned with. It is moreover well proved that the hunted stag provided valuable raw material besides meat, its hide was cleverly processed and many objects and tools were made out of its horn.

A highly appreciated animal was beaver, prized for its beautiful and firm pelts and for its fat, healing certain diseases. Beavers lived in alder woods building their clever dwellings along lakes and river edges. The large per cent of beaver’s bones (47.06%) found in the settlement of Kołożab suggests that the vast valley of the river Wkra with its tributaries, covered by dense and marshy forests, created a perfect habitat for beavers. On the other hand, some kind of hunting specialization may here be suspected, taking into account the high price of beaver’s pelts. This would further suggest an important problem of considering the chance of trading relations of this region with some of the neighbouring countries. For it has been noticed that the settlement of Piwonice, Kalisz distr. lying in the well known trading tract, had about the same per cent share of beaver’s remains in archaeological findings as had Kołożab, (about 38%) or even somewhat higher, reaching the first place in that scale. About 17% of beaver’s remains have been stated in Cedynia, Chojna distr. and Słup,
Środa Śląska distr. (7.14%). We therefore see the importance of this branch of hunting in the given territory, suggesting a problem that would require further study.

We do not state large differences in the quantitative relation of game to domestic animals in the whole of the osteologic materials discovered by archaeological research and statistically elaborated for the Polish lands. It seems, however, that two groups may be distinguished in the representation of wild animals’ bones. The following settlements may be listed into the first group with 6–10% of game’s bones in the osteological material: Cedynia, Chojna distr. — 7.6%, Poznań — 8.5%, Poświętne — 6.39%, Kołozab — 9.77%, Słup — 9.2% and Nowa Huta-Mogila — about 13%. The second group displaying only 0–3% of game’s bones includes: Nowa Cerekwia — 0.6%, Igołomia — 3%, Kobylinki — 2.5%, Aleksandrów — 0% and Piwonice 2.2%.

This review seems to indicate that the population of the investigated settlements listed into the first group should have achieved better hunting results than the inhabitants of settlements listed into the second group. But Piwonice, although showing a low per cent of other wild animals bones, displayed a large share of beaver’s remains. It should therefore again be supposed that some Polish regions were specialized in that branch of industry and trade in the investigated period, i.e. that the settlements of Kołozab and Piwonice had learnt to process beaver’s pelts, preparing them for sale or exchange.

Attention should finally be drawn to the fact that hunters of those times may have often dismembered wild animals they had hunted at some distance from their own dwellings, bringing home only the parts providing best meat. Moreover, the animals hunted or trapped only for their hides and pelts were probably never brought to human abodes. Therefore, the osteological material found in settlements does not fairly represent actual results of hunting. This should be taken into account by the consideration of these problems.

**FISHING**

Research in the settlements of Poświętne and Kołozab have provided certain data proving that the local population had been busy with fishing.

In the settlement of Poświętne bone remains of a perch (*Perca fluviatilis*) have been found in a building dated to the 3rd cent. The settlement assemblage of Kołozab disclosed several tools connected with fishing. They were:

— fragment of an iron leister used for piercing fish, it was dated to the 2nd cent., (found in one of the settlement’s pits). It presented only one
tooth with burr, being part of a many — toothed leister. Fishermen used such implements when fishing big specimens from a boat or raft, and when water happened to be very low, also wading; 68

— bronze glance tip found in a pit, dated to the second cent. It had served for the catching of big rapacious fishes — pike, sheatfish, perch; 69

— iron fishhook, dated to the 1st–2nd cent., found in one of the cremation graves in the cemetery of Kołoząb. Its dimensions suggest hunting big fishes.

The accumulation of fishing implements in Kołoząb evidences the existence of fishing that had very convenient natural conditions provided by the river Wkra, abounding in fishes. The assortment of tools suggests that the local fishermen were well prepared for the catch of big fishes. Fishing was perhaps not the main concern of the population, it had managed anyhow to supply food. Owing to natural conditions fishing played a more important role in Kołoząb than in Poświętne.

FINAL REMARKS

Summing up all the observations concerning agricultural and breeding economy and the exploitation of natural resources in the region lying along the middle and lower basin of the river Płonka and the middle Wkra, it may be concluded that:

(I) One of the main sources of acquiring food was agriculture. On the basis of actually attainable archaeological and natural history sources, of a detailed analysis of the geographic environment and of the general level of productive power, it can be surmised that agriculture was here an established form of economy, based on a higher system of exploiting the soil, by the alternation of fields cultivated or lying fallow. It seems that this system alternated cultivation in a sequence of one, two or — in more favourable conditions, three years. The annealing technique was gradually substituted by a pure ploughing technique. Fields were probably fertilized by animal dung, rendered possible owing to well developed livestock breeding.

(II) Archaeological and natural history sources acquired by research distinctly indicate the intense development of agriculture, expressed by the increasing of corn cultivation. In dependence on local condition, the main species of corn produced in this territory were: ordinary rye, ordinary barley, ordinary millet. Wheat was only scarcely cultivated. Rye and perhaps barley too may have been sown as winter crop.

(III) The development and level of agriculture in the investigated region, lying in a woodland zone and in a forest-and-wilderness subfacies,
did not lag by its farming level behind the regions of south Poland, that lay in a steppe and park-and-forest zone, equalling the level of farming in the northern regions of Great-Poland.

(IV) Domestic livestock breeding played an important role, enjoying good conditions of natural grazing grounds. This branch of economy was based on the developed breeding of cattle of the brachyceric race. It is stated that the region under consideration held the lead in horse breeding, reaching the highest index of specimens in relation to other regions of Poland. Pigs were here less numerous, and sheep played only a second-class role.

(V) On the basis of so far acquired source data it would still be difficult to determine which of the two branches of economy — agriculture or livestock breeding — prevailed in the economic system of the micro-region. It seems most probable that they held an equal rank in farming relations, acting mutually on each other.

(VI) Hunting was more developed here than in other settlement centres, although its meaning in acquiring food did not weigh heavy. It is, however, certain that hunting provided valuable raw material — hides and horn. Beaver pelts started most probably a special furrier industry with its products highly prized in exchange for other goods. This specialization is connected with the settlement of Kołoząb.

(VII) Fishing was practised rather occasionally with preference to the catching of big fish. It is to be supposed that the settlers of Kołoząb practised fishing on a larger scale.

NOTES

1 Problems connected with agricultural and breeding economy in the investigated region may be considered only in the narrow range of space limited by its borders and on the basis of the sources acquired. They are not widely general and should be confronted with problems of territories having a different environment and different specific economy.

2 We shall mention only the most important papers dealing largely with the subject and published in literature. J. Wielowiejski, Przemiany społeczno-gospodarcze u ludności południowej Polski w okresie późnolateńskim i rzymskim [Social and Economic Changes of the Population of South Poland in the Late La Tène and Roman Influence Period], „Materiały Starożytne,” Vol. VI, 1960, pp. 130–165; idem, Rozwój gospodarstwa wiejskiego w okresie późnolateńskim i rzymskim [The Development of Rural Economy in the Late La Tène and Roman Period (2nd cent. B.C. — 4th cent.)], in: Zarys historii gospodarstwa wiejskiego w Polsce, Vol. I, Warszawa 1964, pp. 126–153; cf. also idem, Zagadnienie przelomu w technice uprawy


5 Klichowska, op. cit., tables 11 and 12.

6 Moszyński, O sposobach... p. 228.

8 M. Ziembinska-Tworzydło, Wyniki analiz sporowo-pyłkowych z dwóch torfowisk z okolicy Strachowa i Kołożebia, pow. Płońsk i próba ich interpretacji w odniesieniu do badań archeologicznych na tym terenie, 1965 [The Results of Analyses on Spore and Pollen from two Peatbogs in the Neighbourhood of Strachowo and Kołożab, Płońsk Distr., and an Attempt at Their Interpretation in Relation to Archaeological Research in this Territory, 1965] (typescript); idem, Wyniki analiz sporowo-pyłkowych z dwóch torfowisk niskich z okolic Racząga (Drozdowo i Dzierzążnia) i próba ich interpretacji w odniesieniu do archeologii [The Results of Analyses on Spore and Pollen from Two Low Peatbogs in the Neighbourhood of Raciąż (Drozdowo and Dzierzążnia) and an Attempt at Their Interpretation in Relation to Archaeology, 1967], (typescript).

9 Moszyński, Kultura ludowa..., p. 198; and idem, O sposobach..., p. 229.
11 Cf. Wielowiejski, Rozwój gospodarstwa..., p. 132.
15 Clark, op. cit., p. 121.
16 It seems that palynologic sources have revealed an important fact concerning agriculture in the investigated territory. The growing productivity does not completely destroy forests. This may probably be connected with the soil's fertility and a certain establishment of settlement in this region.
17 The lapse of time in using one field is difficult to determine. Moszyński supposes it to have been 8–12 years running, when he speaks of clearing forests by fire (cf. Kultura ludowa..., p. 140), the case has however not been proved.
18 Palaeopedological research made by K. Konecka-Betley and H. Król.
19 We possess only indirect proofs to such a hypothesis. The very dense popul-
tion would favour that system of agricultural economy; cf. M o s z y ń s k i , Kultura ludowa... p. 139.

20 L o w m i a ń s k i , Początki Polski, p. 297 ff.; i d e m , Podstawy gospodarcze, p. 143; F. F i r b a s Spät- und nacheiszeitliche Waldgeschichte Mitteleuropas nörd- lich der Alpen, Bd. I, No. 2, Jena 1949–1952, p. 141; C l a r k , op. cit., pp. 117–118.

21 Compare for instance pollen diagrams from the peatbog Ordrup Mose and the corelation between tree and herb pollen, particularly Plantago and cereals, and the relation of birch pollen to that of other trees, I v e r s e n , op. cit., passim.

22 Z i e m b i ń s k a - T w o r z y d ł o , op. cit.

23 Advanced systems of soil cultivation depend on technical progress and environment conditions, as stressed by H e n s e l , Słowieńszczyzna..., pp. 12–13 and 14–15. Cf. also Ł o w m i a ń s k i , Początki Polski, p. 291 ff, indicates the important meaning of regionalism in economy; cf. also p. 297 ff, where he suggests the possibility of different systems of soil cultivation occurring parallel.

24 W i e l o w i e j s k i , Przemiany..., pp. 152–153.

25 W i e l o w i e j s k i , Zagadnienie przełomu..., pp. 154, 158, 164.

26 W i e l o w i e j s k i , Zagadnienie przełomu..., p. 154.

27 H e n s e l , Słowieńszczyzna..., pp. 13, 33–34, 78.

28 Cf. W i e l o w i e j s k i , Zagadnienie przełomu..., pp. 163–164.

29 Here are two quite different problems. Cf. M o s z y ń s k i , Kultura ludowa..., p. 139, and Ł o w m i a ń s k i , Początki Polski, pp. 299–300.

30 It is generally accepted that millet yields best crops when sown on the ground of burned forests. Ł o w m i a ń s k i , Początki Polski, pp. 303–304.

31 W i e l o w i e j s k i , Przemiany..., pp. 140–141, considers that the spreading of growing rye was inhibited by a system of alternation following the burning technique. However, as rye dominated in the investigated region, its spread proves established agriculture. H e n s e l does not exclude the cultivation of winter crops in the Roman period: Słowieńszczyzna..., p. 55; Ł o w m i a ń s k i suggests that sowing crops in autumn became popular only at the start of the second millenary A. D. Początki Polski, p. 302.

32 Ł o w m i a ń s k i , Początki Polski, p. 302.

33 H e n s e l indicates such a possibility in: Słowieńszczyzna..., p. 54–55.

34 S. G o d y n i c k i , Materiał kostny zwierzęcy w osadach z późnego okresu la- teńskiego i wczesnego okresu wpływów rzymskich w Poświętym i Kołozbii [The Material of Animal Bones in a Settlement from the Late La Tène and Early Roman Influence Period in Poświętne and Kołozb, Płock Distr.], (typescript).


36 M. S o b o c i ń s k i , Szczątki kostne zwierząt z osady II–III w.n.e. w Słupie, pow. Środa Śląska [Animal Bone Remains from a Settlement of the 2nd–3rd cent. in Słup, Środa Śląska Distr.], “Silesia Antiqua,” Vol. III, 1961, pp. 150–163.

37 L. S y c h , Szczątki kości zwierzęcych z późnolatenskiej i rzymskiej osady w Mogile k/Krakow [Animal Bone Remains from a Late La Tène and Roman Period in the Settlement of Mogila, near Cracow], (investigated in 1967), MA, Vol. II, 1960, pp. 231–236.

38 Z. J a w o r s k i , Czaszki bydła rogatego i świń domowej z wykopališk w Igo- łomii i Tropiszowie, pow. Miechów [Skulls of Cattle and Domestic Swine Excavated


42 B. Baranowski, Chów bydła w drugiej połowie XVII i w XVIII wieku w Łęczyckim i na terenach sąsiednich [Cattle Breeding in the 2nd Half of the 17th and in the 18th Cent. in the Region of Łęczyca and the Neighbouring Territories], St. DGW, Vol. I, 1957, pp. 198–258.

43 Moszyński, Kultura ludowa..., p. 104 ff.
44 Baranowski, op. cit., p. 226.
45 Jaworski, op. cit., p. 31.
46 Godynicki, op. cit., he observes that bones of that species are far less numerous than those of shorthorned cattle.

47 Kubasiewicz, Gawlikowski, Szczątki zwierzące..., p. 150 ff.

48 K. Krysiak, Szczątki zwierzęce z okresu rzymskiego z kurhanów Suwalki [Animal Remains from the Roman Period found in Tumuli from the Neighbourhood of Suwałki], “Wiadomości Archeologiczne,” Vol. XXV, 1958. He assumes that horses may have been caught for their meat and hide.

49 Boesneck, op. cit., p. 216. He determines the height of a Celtic horse to have been 150–160 cm.


54 Moszyński, Kultura ludowa..., p. 106 ff.
55 Troels-Smith, op. cit., p. 5 ff.
56 Moszyński, Kultura ludowa..., p. 107.

60 Wielowiejski, Rozwój gospodarstwa..., p. 150; W. Haarnagel, Vorläufiger Bericht über die Wurtengrabung auf der Feddersen Wierde bei Bremerhaven, “Germania,” No. 34, 1956, pp. 125–141; idem, Zur Grabung auf der Feddersen

61 Hensel has drawn attention to that problem in Słowiańszczyzna..., pp. 54–55.

62 Clark, op. cit., p. 146.


64 Unpublished research of I. Górska from the Institute of the History of Material Culture, Polish Academy of Sciences. The bone material has been elaborated by C. Wiland.

65 Krysiak, Materiał zwierzęcy..., pp. 97–102.


67 Krysiak, Materiał zwierzęcy..., p. 97 ff.

68 M. Znamierowska-Prüfferowa, Rybackie narzędzia koine w Polsce i krajach ościennych [Fisherman’s Piercing Implements in Poland and the Neighbouring Countries], Toruń 1957, pp. 40–41 and 126–127.